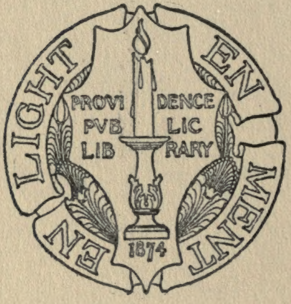

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FARMERS' BULLETINS
Nos. 1701-1725

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PREPARED IN THE INDEXING SECTION

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WASHINGTON : 1934

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U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1701

CORNCRIBS FOR THE CORN BELT

1862 1889

BETTER METHODS of building grain-storage structures, explained in this bulletin, will help to avoid losses caused by faulty construction. In the Corn Belt small grains are generally grown in rotation with corn, and storage for them as well as for the corn must be provided. In the same region the use of elevating equipment on farms has made it desirable to use high buildings for storing corn and small grains. This publication presents designs for several types of grain storages adapted to the Corn Belt.

Washington, D. C. **Issued April, 1933**

CORNCRIBS FOR THE CORN BELT

By M. A. R. Kelley, *Agricultural Engineer, Division of Structures, Bureau of Agricultural Engineering*

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ON THE FARM is the best place to store corn, because 85 per cent of the crop is fed to farm animals, and only about one-fifth of the corn is shipped out of the county where it is grown. Even when produced as a cash crop, corn is seldom hauled direct from the field to the elevator, hence some provision must be made for storing it until it is to be used or sold.

A substantial, permanent crib is the most economical and satisfactory structure for storing corn. Wire or slat pens and cheap shed cribs are lower in first cost and are useful in emergencies—as when the crop is extraordinarily large or buildings have been destroyed by fire or other cause—but increased loss from weather and vermin may more than offset this initial saving. Studies in Iowa and Illinois have shown that a good substantial crib can be built and maintained at an annual charge of 3 cents per bushel of its capacity.

A well-designed and well-constructed modern crib provides economical storage, ventilation ample to keep the grain in condition and to improve its quality, and protection against losses through weather and vermin. It is durable, of low maintenance cost, safe against damage by wind, storm, or fire, and attractive in appearance. It is also arranged for the use of good labor-saving equipment for filling and emptying the storage spaces.

PRELIMINARY PLANNING

It is unwise to attempt to erect large grain storages without carefully prepared plans. Poor judgment in the selection of the site, lack of knowledge of the strength of materials, and poor workmanship have caused many failures. The most common errors are constructing inadequate foundations, insufficient bracing and tying, and overloading structural members.

The site for the corncrib should be well drained, particularly if the crib is to have a concrete floor. It should be convenient to the road from the field and for stock feeding. The long axis of the crib is usually placed north and south, to get the greatest benefit from the winds and the sun in drying the corn.

FACTORS AFFECTING STORAGE

MOISTURE CONTENT

For safe storage at terminal elevators the moisture content of shelled corn should be not more than about 16 per cent in winter and 14 per cent in summer. The percentage of moisture in ear corn at harvest varies with the season and the dryness of the corn when husked. Iowa corn commonly contains 20 to 25 per cent of moisture in early winter but dries on the cob without damage in properly ventilated cribs. Soft or immature corn may contain as much as 65 per cent of water, and requires special handling.[1] Such corn is often dried artificially or fed early, to avoid losses through its spoilage. Properly built cribs and good handling on the farm reduce the losses.

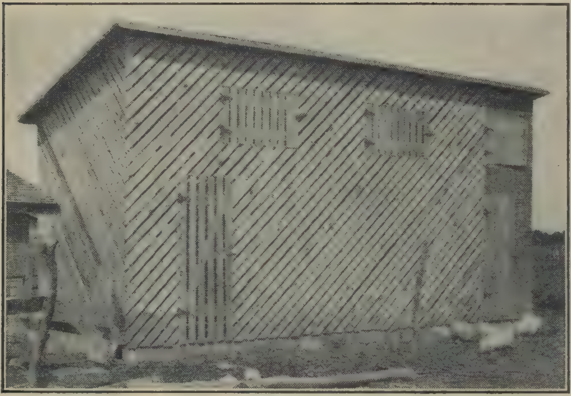


FIGURE 1.—Small corncrib with grain bin in one end, on good foundation but without protection against rats

HARVESTING METHODS

Modern harvesting methods have introduced new problems in grain storage. The old method of hand filling with the scoop shovel limited the height of the crib to 10 or 12 feet. Hand husking was slow and the corn was distributed through long cribs to facilitate its drying.

Modern unloading and elevating equipment have permitted higher cribs and the mechanical corn picker has speeded up harvesting until the daily storage often exceeds 500 bushels. Large masses of corn dry out more slowly, heat more quickly, and cool off less rapidly than smaller masses, with greater danger of spoilage unless the crib is well ventilated. The drying, shrinking, and settling of large masses of corn that is stored before it dries, strain the crib more than when slower methods of filling are used, and sometimes cause its failure.

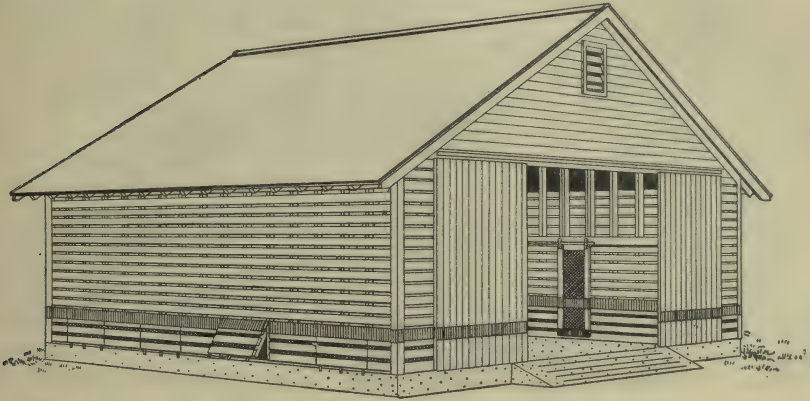
It is generally believed that corn must be cribbed before it can be shelled, yet demonstrations of new machines have shown that corn can be gathered, shelled, and cleaned, and the stalks shredded in one operation. Should such machines prove practical, their use will add to the problems of properly storing and drying corn.

---

[1] See Department Circular 333, Handling the Soft-Corn Crop.

TYPES OF CONSTRUCTION

Cribs for storing corn or corn and small grain may be made of wood, masonry, or metal. For emergency or temporarily, ear corn can be stored in cribs made of woven or slatted wire fencing.



DESIGN NO. 521

FIGURE. 2.—Double corncrib with capacity of 2,000 bushels of ear corn, and with a 12-foot driveway. The screen and the metal strip above the foundation keep out rats

Early forms of corncribs were built of lumber with shed roofs. (Fig. 1.) Large capacity was obtained by building long cribs or a number of short ones. The height of this type of crib was limited to the height to which corn could be raised with a hand scoop.

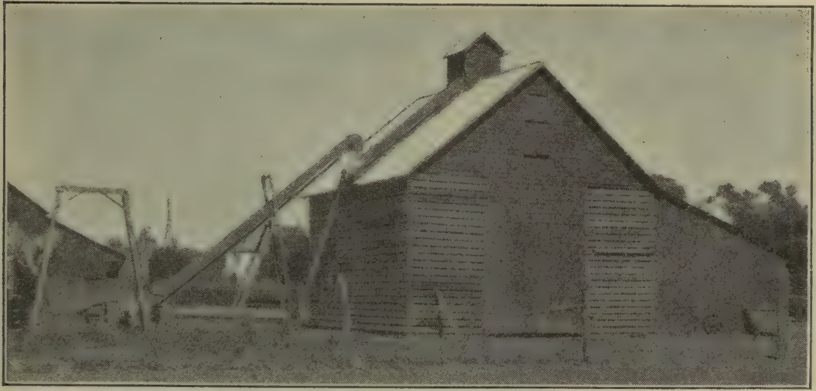


FIGURE 3.—Double crib of early type, with grain bin over driveway, and portable elevator with extra section on roof of crib. Closed wagon shed on side of crib obstructs circulation of air

Later in the development of storage structures, two shed-roofed cribs were joined as shown in Figure 2, separated by a driveway in which light machinery and vehicles could be stored.

Introduction of the farm elevator led to development of high cribs with storage for small grains over the driveway and distribution to the various parts of the structure by spouts from a central point. (Fig. 3.) Cribs were later arranged with elevators inside. (Fig. 4.)

Common building tile with the openings exposed were formerly used for rectangular cribs. Special slotted corncrib tile are now used, particularly for cribs with curved walls. (See cover illustration.) The early tile cribs were without driveways; now driveways and inside elevators with overhead bins are the rule. Figure 5 shows a good type of rectangular tile crib having the walls reinforced with angle irons outside the building which form the anchorage for inside cross-ties. This crib is built of special blocks having the interstices smaller than in ordinary building tile in order to keep out vermin. The upper six courses are of solid tile and protect the top surface of the corn against storms.

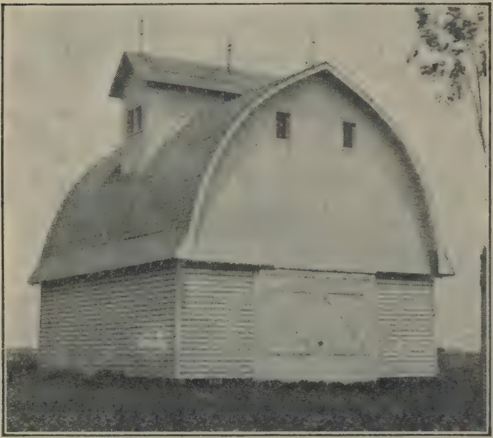


FIGURE 4.—Combined corncrib and small-grain storage, with cupola to give headroom for inside elevator

The most common form of concrete crib is circular or oblong, built of staves and held together by means of exposed iron hoops. (Fig. 6.) The better hoops are galvanized, as black iron hoops leave unsightly streaks of rust on the sides of the crib.

Concrete corncrib staves commonly have either interlocking ends as shown in Figure 7, or square ends as shown in Figures 6 and 8. The latter form is less likely to crack. Some of these staves have rods (fig. 7) and others have louvers (figs. 6 and 8) of concrete or metal to keep rats from entering the openings. Metal rods or louvers should be galvanized to prevent corrosion.

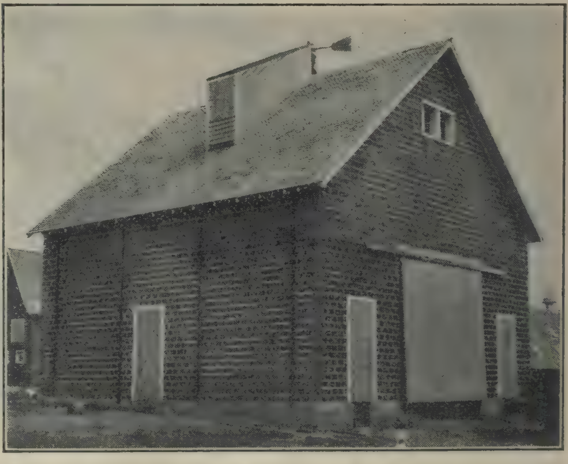


FIGURE 5.—Well-built rectangular crib of hollow tile, with angle irons for tie-rod anchors. Side door gives ready access to crib

More general use of metal cribs has been retarded by numerous examples of flimsy construction and poor-grade metal and galvanizing. Durable cribs of perforated metal in many shapes and sizes may be obtained from reliable firms. Metal cribs of 500-bushel capacity or less are usually circular. Cribs of

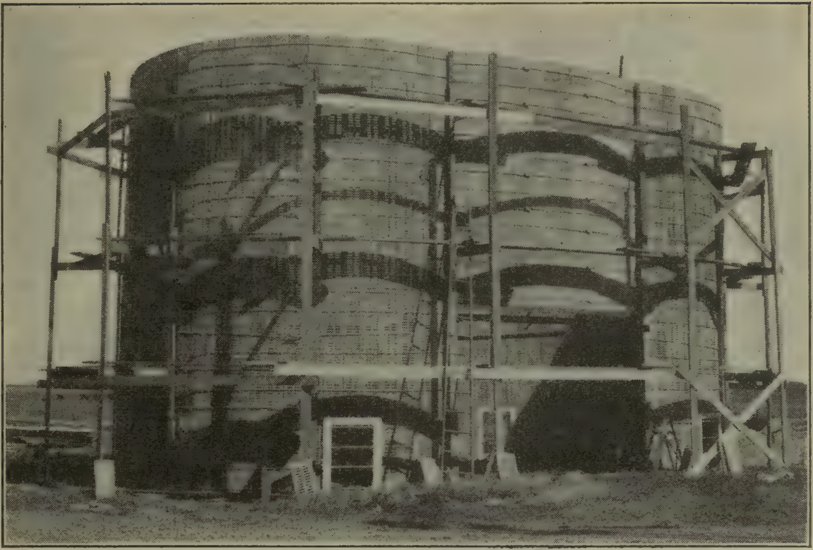


FIGURE 6.—Large concrete-stave crib with central bins, under construction. Hoops are threaded through holes in precast concrete frame for shelling door

larger capacities are rectangular or oblong. (Fig. 9.) A double crib with grain bin over the central driveway is shown in Figure 10.

Emergency cribs made of woven-wire fencing are shown in Figure 11. A better form of wire crib with a metal band which affords protection from rodents is shown in Figure 12.

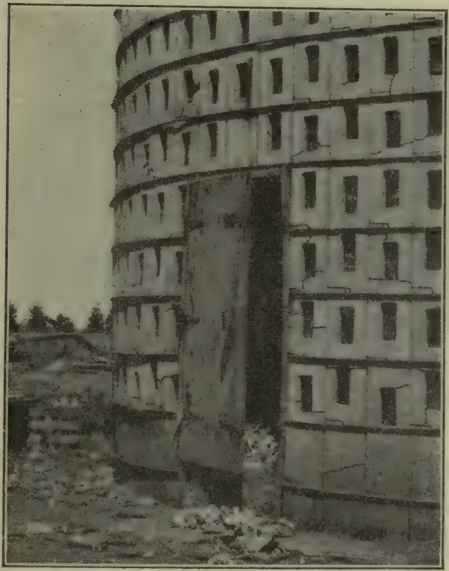


FIGURE 7.—Early type concrete crib of interlocking staves. Poorly designed door frame and poor foundation caused failure shown by cracked staves

SPACE REQUIREMENTS

The size of the crib should be determined largely by the average quantity of corn grown each year and by whether corn is grown for sale or for consumption on the farm. Permanent cribs with a capacity about 5 per cent greater than the average crop are usually more than sufficient to take care of the corn. When unusually large crops are harvested under such conditions about one-fifth of the corn must be stored in temporary cribs inside or outside of farm buildings.

It is common practice to provide 2½ cubic feet of storage space for each bushel of cleanly husked ear corn to be stored. To calculate the capacity of a crib in bushels of ear corn, multiply by 4 the volume in cubic feet of the available storage space, and divide the result by 10. If snapped or jerked corn is cribbed with the husks on, the capacity of the crib will be reduced about one-fifth. In computing the storage space in a corncrib, the over-all width of the crib should be reduced by 2 inches when 2 by 6-inch studs are spaced 24 inches center to center, by 4 inches when the studs are spaced 16 inches, and by 6 inches when the studs are spaced 12 inches apart.

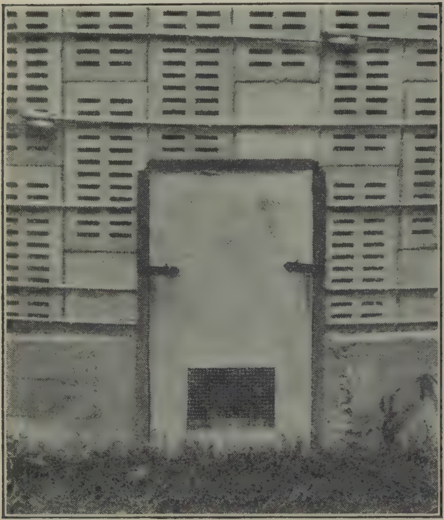


FIGURE 8.—Rectangular concrete corncrib staves, with interstices small enough to keep out rats, resting on substantial concrete foundations; hoops anchored to channel-iron doorframe; screened opening into shelling trench

A bushel of small grain or shelled corn occupies approximately 1¼ cubic feet of space. To calculate the capacity of grain bins in bushels multiply the volume in cubic feet by 8 and divide the result by 10.

While the capacity of the corncrib is determined by farm requirements, the proper width depends on the climate and on the varieties of corn grown. A width of 8 feet is considered standard in most of the Corn Belt, though widths of 6 and 7 feet are not uncommon in Minnesota, northeastern Iowa, northern Illinois, Wisconsin, Indiana, and Ohio. Cribs only 4 feet wide are sometimes used in the Eastern States, partly because of the small quantity of corn raised. In western Kansas and Nebraska a width of 10 or 12 feet is commonly used and generally proves satisfactory.

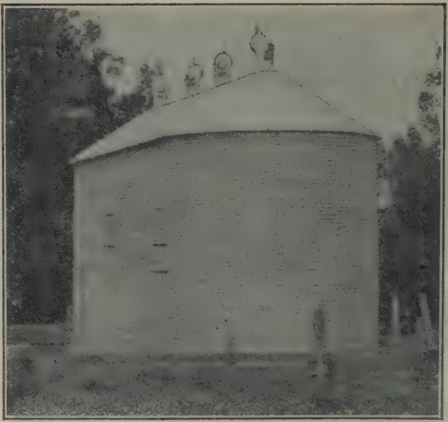


FIGURE 9.—Oblong metal crib. Ventilators on roof connect with metal flues extending to floor of crib

Table 1 shows the capacities of combined corncribs and granaries of various lengths and heights.

Space for grain-handling equipment should be provided in permanent cribs. Cleaning, grading, and treating seed can be done in the driveway.

The minimum width of driveway for inside installations of elevating equipment is 9 feet. A width of 10 or 11 feet is more satisfactory. Eleven feet is ample and utilizes 12-foot joists economically. Wider driveways are used where oats form a large part of the small-grain crop, but they are not advisable where heavier grains are to be stored, because bin floors above wide driveways are likely to be overloaded. Large driveways encourage the storage of all sorts of machinery and junk that interfere with convenient handling of the grain.

STRUCTURAL DETAILS

The essentials of a satisfactory corn and grain storage are strength, dryness, and durability. The loads to be supported are heavier than those in other farm buildings and tend to force out the side walls as well as to break down the floors. The framing should be designed and built to resist safely both the load of the grain when the crib is full and the thrust of the wind when the crib is partly or entirely empty.

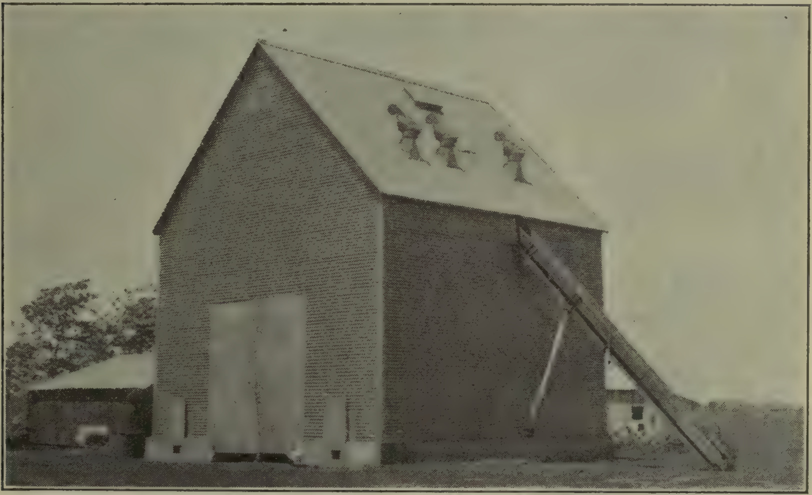


FIGURE 10.—All-steel crib (steel framing, perforated-metal sides, and corrugated roofing) with portable elevator

TABLE 1.—*Capacities of combined corncribs and granaries*[1]

Height of studding in outside wall	Crop stored in—	Capacity per foot of length	Height of studding in outside wall	Crop stored in—	Capacity per foot of length
		Bushels			*Bushels*
10 feet	Bins	34.6	16 feet	Bins	86.6
	Cribs	75.1		Cribs	109.6
	Total	109.7		Total	196.2
12 feet	Bins	52.0	18 feet	Bins	104.0
	Cribs	86.9		Cribs	121.0
	Total	138.9		Total	225.0
14 feet	Bins	69.3	20 feet	Bins	121.3
	Cribs	98.2		Cribs	130.8
	Total	167.5		Total	252.1

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[1] For type of construction see fig. 19. Width of each crib, 8 feet; width of driveway, 11 feet; grain bin measured from 10 feet above crib floor (height of driveway) to 4 feet above outside plate; average height of ear corn measured to 2½ feet above outside plate.

FOUNDATION

A permanent crib should have an ample, well-made foundation. Poor foundations probably cause more corncrib failures than does any other one thing. Figure 13 shows a concrete foundation which, being set on top of the ground, is being undermined by rain and the trampling of livestock. To avoid serious damage to the foundation and building, repairs should be made at once. Standing water may soften the soil under a portion of the building and cause unequal settling. Eave troughs, down spouts, and proper drainage around the building will eliminate this cause of trouble. Figure 14 shows piers heaved out of line by frost. Foundations of uncemented field stones are likely to settle unevenly or may allow the sills to slip.

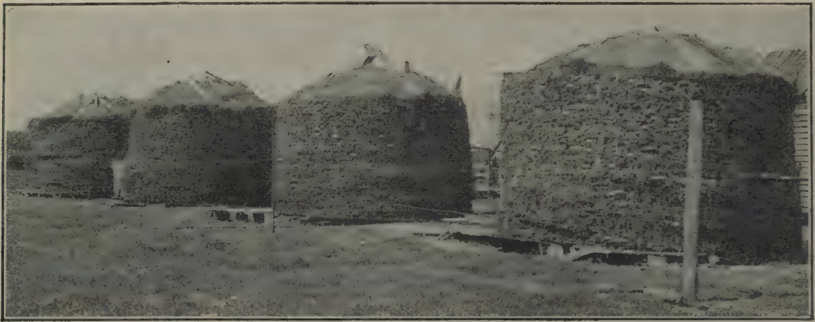

FIGURE 11.—Emergency cribs of woven-wire fencing, on a plank floor which affords excellent harbor for rats. Cheap in first cost but expensive when losses from elements and rodents are considered.

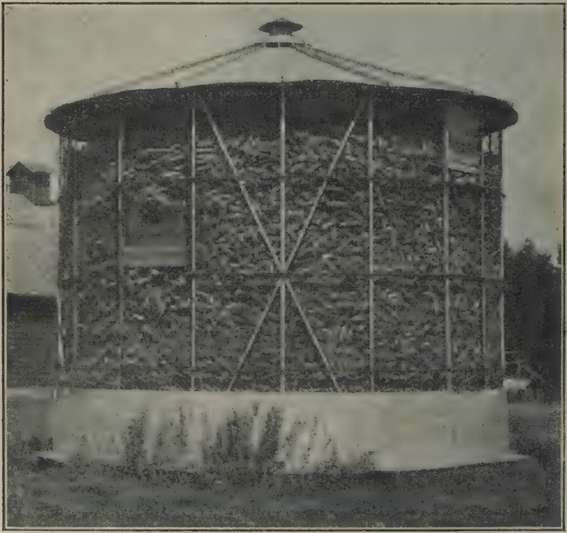

FIGURE 12.—Improved form of temporary crib, with screen-lined floor and metal band around bottom to keep out rats.

Two good types of foundations[2] are shown in Figure 15. Footings should rest on firm ground and be deep enough to avoid heaving caused by frost or undermining by rats or livestock. Ordinarily, the footing should extend at least as far below the ground as the foundation wall extends above, to provide stability. If a wood floor is to be used, the foundation walls should be carried far enough aboveground to give good ventilation and long life to the sills, studs, and joists, as indicated in Figure 15, C. Half-inch bolts for anchoring the sills should be set 12 inches into the wall and not more than 4 or 5 feet apart. If the foundation is a continuous wall, screened openings should be made to permit circulation of air and avoid rotting of timbers. Footings may not be necessary on some soils, but are generally advisable. If a pit for elevating equipment is to

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[2] See Farmers' Bulletins 1279, Plain Concrete for Farm Use; 1480, Small Concrete Construction on the Farm; and 1638, Rat Proofing Buildings and Premises.

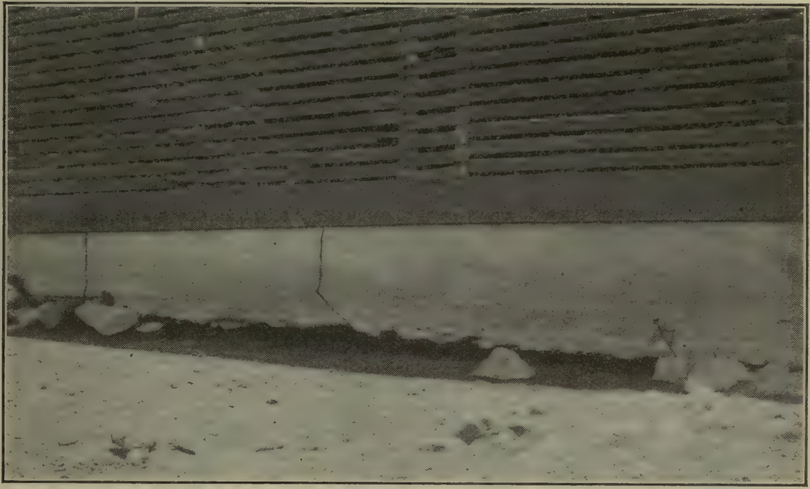

FIGURE 13.—Shallow foundation made insecure by washing away of soil underneath

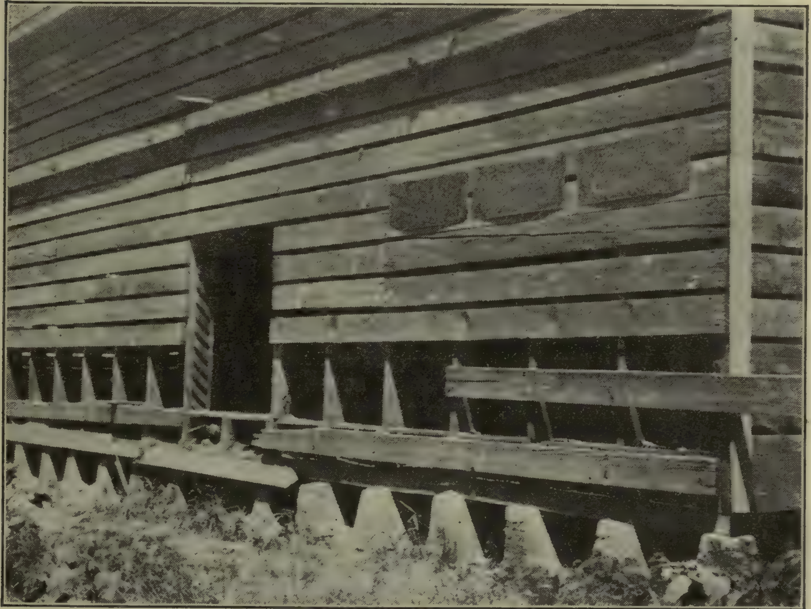

FIGURE 14.—Shallow piers make an unstable foundation. About one-third of these are out of alignment

be provided, the adjacent footings should be placed below the level of the pit.

Where continuous foundation walls are used, as in Figures 15 and 16, 12-inch footings and 8-inch concrete walls are adequate in firm, well-drained soils. On soils which furnish poor bearing the width and depth of the footing should be increased in proportion to the bearing power of the various types of soil, as given in the next paragraph. Where the bearing is not good, it is also well to use reinforcing rods in the footings.

Piers do not furnish as good support as walls. They should be proportioned according to the load to be carried and the bearing power of the soil. The load on a pier may be computed on the basis of the following weights of grain per cubic foot: Ear corn, 28 pounds; shelled corn, 45 pounds; wheat, 50 pounds; barley, 39 pounds; oats, 26 pounds. Loads should be computed for cribs and bins filled to capacity and with about 10 per cent added for the weight of the building. In ordinary practice the bearing power of soils is assumed to be as follows: For hardpan or firm dry sands, clays, gravels, or mixtures of them, not more than 3 tons per square foot of bearing area; for ordinarily well-drained subsoils, not more than 2 tons; for alluvial soils or wet clay, not more than 1 ton. In some localities, experience may indicate that these bearing powers are too great. Unless a foundation rests on bed rock some settling may be expected, and precautions should be taken to render it not only slight but also uniform.

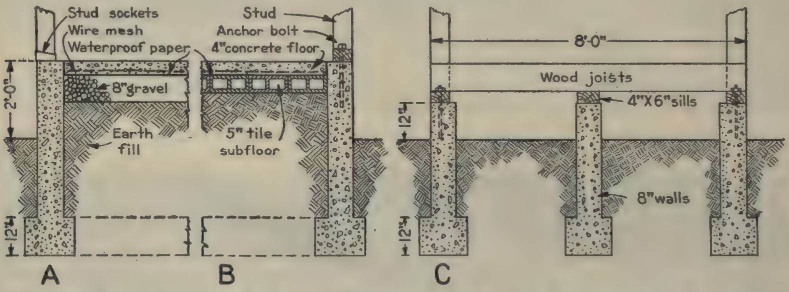

FIGURE 15.—Suggestions for foundations and floors. A, Foundation and concrete floor on 8 inches of gravel or broken-stone fill; stud sockets or anchors used; depth of foundation varies with ground conditions. B, Concrete floor on building tile for dryness; wood sills bolted to foundation. C, Foundation of three continuous concrete walls for high crib with wooden floor

Metal cribs should be strongly anchored to concrete foundations. The sills should be set in asphalt to prevent entrance of water from the sides or some other means should be used to drain the water off the foundation and prevent its entrance into the crib at the foundation line.

FLOORS

All floors should be sufficiently smooth to provide a good surface for shoveling. Concrete floors laid over building tile or on 6 to 8 inches of gravel or broken stone fill (fig. 15, A and B) are commonly used in modern cribs. It is important that these floors be well drained and where the soil is moist there should be two or three layers of waterproof paper just under the concrete.

Wood floors (fig. 15, C) should be of seasoned lumber and high enough above the ground to provide no harborage for rats.

FRAMING

A satisfactory corncrib or granary must have a substantial frame. A common mistake, resulting in many failures, is building corncribs too tall, particularly when inexperienced labor is used. When the crib is to be 18 feet high or more, the construction should be supervised by a competent builder.

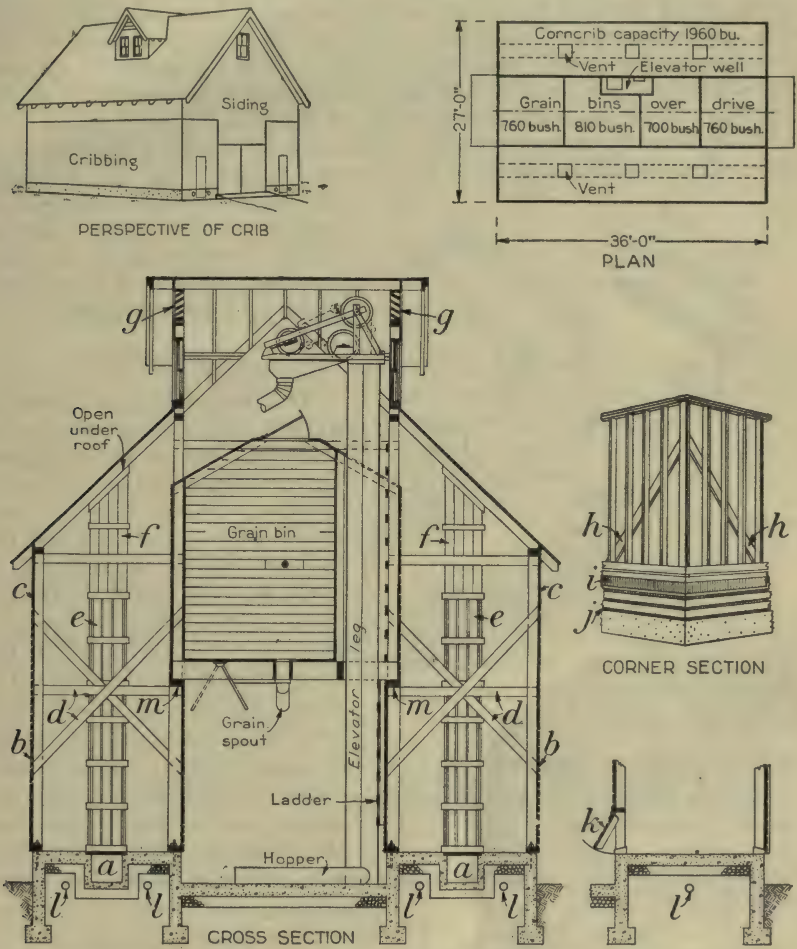

FIGURE 16.—Construction of frame corncrib and granary, design No. 2587; *a*, Shelling trench; *b*, bevel-edged cribbing; *c*, solid sheathing; *d*, cross bracing; *e*, slatted ventilators; *f*, tightly boarded ventilator shaft; *g*, louvers; *h*, corner bracing; *i*, 8-inch metal-band rat proofing; *j*, ½-inch wire-mesh rat proofing; *k*, shelling door; *l*, tile drain; *m*, wall plate supporting grain bin

Green lumber should not be used, as shrinkage may cause objectionable cracks and warping. Woods most commonly used are, in order of their relative strength, oak, yellow pine, fir, spruce, common white pine, hemlock, and cottonwood. Because of its durability many farmers use oak for sills and joists and for the studs of the outside wall. The life of less durable kinds of wood can be greatly increased by proper treatment with creosote or other wood preservatives.[3]

SILLS

Wood sills should be attached to the foundation by bolts. They should be of durable material, usually at least 3 inches thick, and as wide as the studs. Ventilation around them and protection from moisture increase the life of sills and joists. Figure 17, C shows how drainage and ventilation may be improved by use of a shallow concrete subsill with drain openings or weep holes.

If the floor is of concrete the sills may be omitted and the studs anchored to the foundation walls by stud sockets (fig. 17, A and B) set firmly in the concrete and spiked to the studs. Rotting of the lower ends of the studs may be avoided by dipping the ends in a preservative.

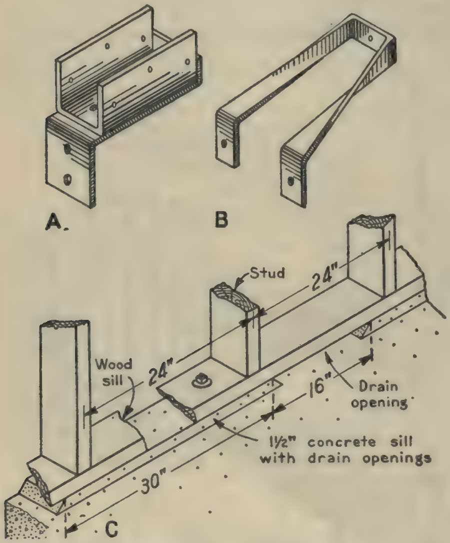

FIGURE 17.—Types of anchorage for studs: A, Pressed-metal anchor; B, strap-iron anchor; C, wood sill bolted to concrete foundation, with weep holes through concrete subsill for floor drainage

FLOOR JOISTS

The size of floor joists required depends on their span and the load to be supported. In deep bins and cribs the arching action of the grain tends to put part of the load on the walls, decreasing the load on the joists. Table 2 gives suggested sizes for joists with a strength equal to that of good-quality oak or yellow pine. Larger sizes or closer spacing is required for timbers of less strength. Home-sawed joists should be cut 2½ or 3 inches thick, since the greater thickness provides better bearing and longer life. A 3 by 8 inch joist is approximately as strong as one 2 by 10 inches.

STUDS

If cribs are properly cross braced, it is common to use 2 by 6 inch studs spaced 24 inches on centers in cribs up to 18 feet in height from foundation to outside wall plate. In higher cribs heavier studs should be used, 2 by 8 inches for heights up to 24 feet. It is difficult to shovel or scoop between studs that are less than 18 inches from center to center.

Formerly, in corncribs with grain bins over central driveways, the studs next to the driveway often were continuous from sill to top of bin, and the bins were supported on ribbons let into the studs or on blocks spiked to the sides of the studs. The former method weakened the studs and the latter placed too much strain on the nailing. It is better practice to use short studs and plate off below the bins, as shown at *m* in Figure 16.

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[3] See Farmers' Bulletin 744, Preservative Treatment of Farm Timbers.

TABLE 2.—*Suggested sizes of floor joists for corncribs*

Type of foundation	Height of crib to outside wall plate	Spacing of joists	Size of joists if length is—	
			8 feet	10 feet
	Feet	*Inches*	*Inches*	*Inches*
2-wall	8	24	2 by 10	------------
	12	24	2 by 12	------------
	12	12	2 by 10	------------
3-wall[2]	12	24	2 by 8	2 by 10
	16	24	2 by 10	2 by 12
	20	18	2 by 10	2½ by 10
	20	24	2½ by 10	2½ by 12

[1] 1 wall under each line of studding.
[2] 1 wall under each line of studding and 1 wall supporting middle of joists.

Reinforced-concrete lintels and girders are sometimes used to support grain bins over the driveway in a masonry crib. These lintels and girders must, of course, rest on substantial footings and columns. This type of construction is very satisfactory if properly designed and built by experienced men, but poor design or workmanship has caused many failures. Steel I beams of proper size are very satisfactory for supporting grain bins over driveways. Second-hand bridge beams can sometimes be secured at small cost.

BRACES AND CROSSTIES

Omission of bracing is a common fault in storage structures and often results in racked buildings (fig. 18) or bulged walls. Two kinds of braces are needed: (1) Diagonal braces nailed to the studs (fig. 16, *h*) to resist wind[4]; and (2) crossties between studs to resist the outward pressure of the grain (fig. 16, *d*).

Some good arrangements of crossties for cribs of various heights are shown in Figure 19. All ties should be well fastened at the ends. The bottom of the cross braces should be high enough for a man to walk under, a minimum height of 6 feet being desirable.

Ear corn when placed in the cribs settles as it dries and tends to wedge together. The settlement sometimes is as much as 2 feet or more, depending on the original depth and the dryness of the corn. If crossties are placed on every stud, they may support the entire load of corn above them while the corn below settles away. This increases the liability of broken ties, and the danger from falling corn when the crib is being emptied. Therefore crossties should not be placed closer than 4 feet and should be designed to support heavy loads without damage. Even heavy crossties can be broken by sudden sliding of large masses of corn. To avoid this danger the grain should be kept moving steadily from the top while the crib is being emptied.

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[4] See Leaflet 87, Wind-Resistant Construction for Farm Buildings.

Iron rods 8 to 10 feet apart and attached to stay timbers are often used for crossties. These rods must be supported similarly to those in Figure 19, D, or the weight of corn above will pull loose their anchorage or pull in the side of the building. Stay timbers spiked outside the studs (fig. 14) should be protected by flashings to prevent water from getting behind them. Sometimes the stay pieces are fastened on the inside of the studs by **U** or hook bolts, as shown in Figure 20.

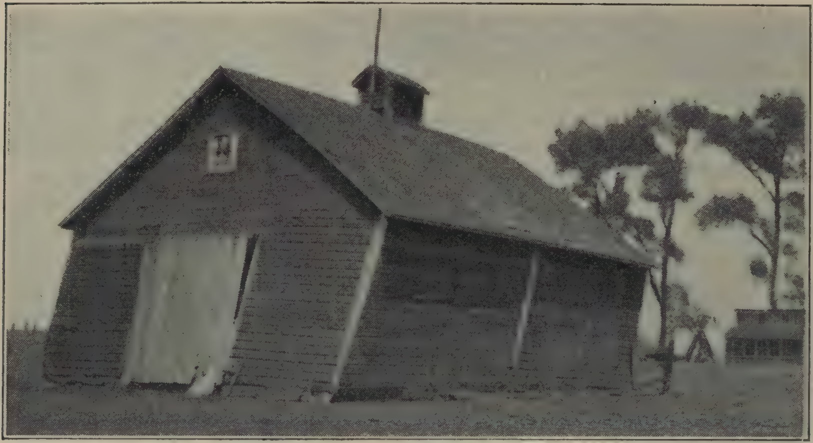

FIGURE 18.—Bracing cribs when they are built avoids the conditions shown. Undermining of shallow foundation by rats hastened this failure

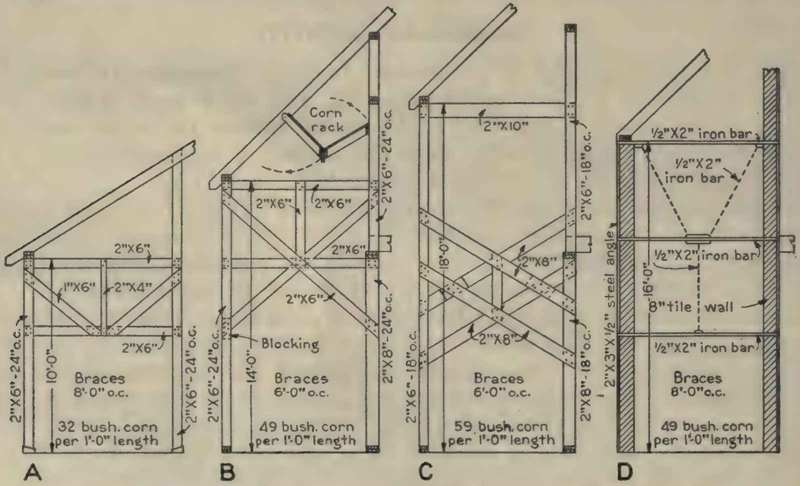

FIGURE 19.—Suggestions for bracing cribs 8 feet wide: A, For 10 feet height; B, for 14 feet height; C, for 18 feet height; D, for tile crib 16 feet high. The letters "o. c." denote "on center" and apply to spacing

One recommended form of cross bracing for masonry and metal cribs is shown in Figure 19, D. Unsupported horizontal ties of one-half by two inch bars usually will fail because of the weight of corn on them, but are safe if the vertical and diagonal supports shown by dotted lines are added. Joints must be secured with bolts not smaller than five-eighths inch. It is good practice to use pilasters to stiffen the walls in large masonry cribs.

SIDING

Thorough curing of corn requires an abundance of fresh air to carry away the moisture. Siding boards on corncribs are spaced one-fourth to one and three-fourths inches apart to permit circulation of air. Siding may be put on horizontally, vertically, or diagonally. As a rule horizontal cribbing slats 4 to 6 inches wide with edges beveled to aid in keeping out rain are used on the outside wall. (Fig. 20.) Vertical or diagonal siding does not need beveled edges. Common boards, placed horizontally, are ordinarily used on the driveway side. The siding should be well nailed, with tenpenny nails. Vertical siding permits rain to drain off readily, but is little used except on small cribs. Diagonal siding braces the walls, but requires somewhat more labor in applying and is not attractive in appearance. To protect the top of the corn pile from rain or snow after the corn in a high crib has settled, the upper 2 to 4 feet of the crib should be boarded tightly, as shown in Figures 16, *c* and 21.

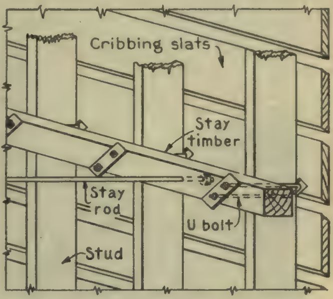

FIGURE 20.—Stay timber secured to studs with U bolts, the tie rods extending through the timber

Openings or doors in the side walls or at the ends of shelling trenches (fig. 16, *k* and *a*) should be provided to avoid the necessity of tearing off siding whenever corn is shelled. This practice causes rapid deterioration of the crib. (Fig. 14.)

OVERHEAD BINS

The boxing or sheathing of the small-grain bins should be well-dried shiplap or matched lumber. Only dry lumber should be used, and it should be carefully piled to prevent injury from rain before it is put in place. The sheathing is best placed on the inner side of the bins more than 10 feet deep, otherwise the pressure may loosen the nails.

Hopper-bottom grain bins are hardly necessary if the grain is moved only once a year. Where it is moved frequently, as on a stock farm, one or more hopper bins may be convenient. A semihopper bin may easily be provided by placing the joists as shown in Figure 22, A. The crossed joists help to brace the center of the structure with little added cost or loss of space.

The length of span of the overhead joists is determined by the width of the driveway. For economy in construction this width should be the minimum that will meet the requirements. Very wide driveways require especially heavy joists, steel girders, or some form of truss to support the grain overhead. The supports should be framed by an experienced man and care taken to make strong joints.

Figure 22 suggests three ways of supporting bins when the maximum depth of small grain is not more than 12 feet. Joists for oat bins need not be so large as those shown in Figure 22, but in the Corn Belt the bins may be needed for wheat or shelled corn and should be strong enough for such grains. When bins 12 feet or more in depth are needed to provide the desired capacity, it may be more economical to store the grain in another building.

ROOFS

Gable roofs are most commonly used on wood corncribs. On small cribs a pitch of approximately 8 inches to the foot is often used. (Figs. 1 and 18.) Half pitch (12 inches to the foot) is used most commonly on larger cribs and cribs intended to be filled by an elevator. Sometimes a gable roof with ridge perpendicular to the driveway will give space, without a cupola, for the elevator head.

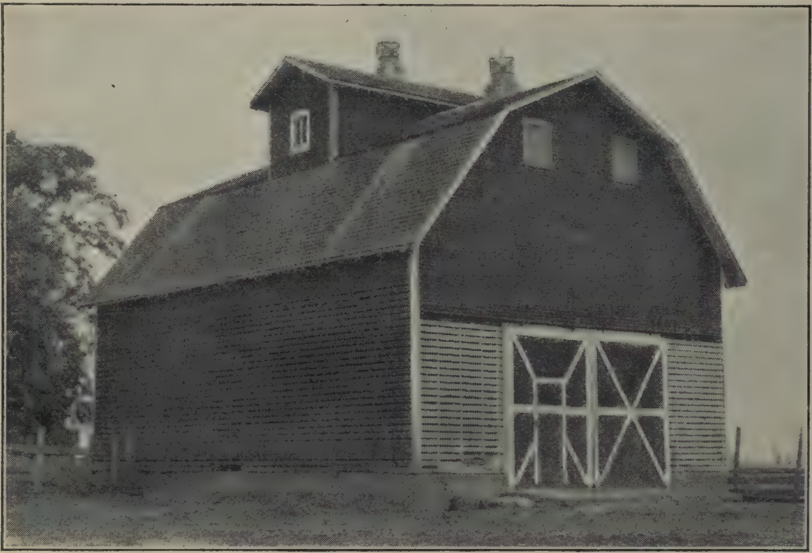

FIGURE 21.—Gambrel-roof corncrib and granary, with small section of tight sheathing below plate for storm protection

The gambrel roof (fig. 21) is used to advantage when large bin storage is needed, or to match the style of other buildings. A gothic roof (fig. 4) has the same advantage, but shingles may not lie flat on such a sharply curved roof.

If prepared roll roofing is used it should be of good quality, not easily torn off by wind. Good-quality corrugated iron and other metal roofings are satisfactory for corncribs when properly laid to exclude rain and snow.

CUPOLA

A cupola is generally used to permit placing the elevator head high enough so that the grain can be spouted to any part of the building with less trouble and expense than cross conveyors require. The cupola also aids in ventilating the building by permitting the vapor rising from the drying grain to escape through the louvers (fig. 16, *g*) or windows.

The width and length of the cupola will depend on the space required for the elevator leg and head. (Fig. 16.) Some elevators require a cupola extending the full width of the driveway (figs. 4 and 21), while others do not. (Fig. 5.) For best appearance, the center of the cupola should be at the ridge of the main roof. When possible, consult the manufacturer's layout for the elevator to be used before building the crib. It is seldom advisable to build a cupola less than 6 feet wide (measured parallel to ridge of main roof); 8 feet is better and does not look too large on a crib 36 feet or more long. An elevator leg having buckets or cups 8 by 16 inches—the common size—requires a working space 21 to 30 inches wide and a minimum of 7 inches clearance behind. Elevator heads are usually 5½ to 6½ feet long. The height of the cupola will depend on the length and width of the crib. On a crib 30 feet or less in width and not over 40 feet long, with half-pitch roof, the cupola walls should extend 2 feet or more above the ridge of the main roof. A half-pitch roof at right angles to the main roof has a good appearance.

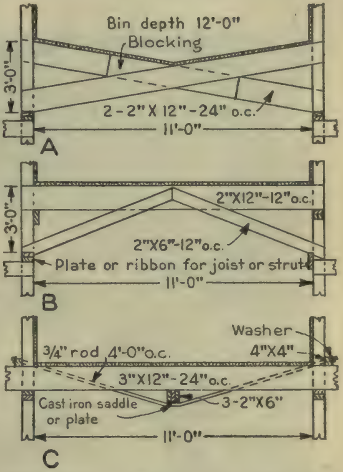

FIGURE 22.—Supports for grain bin of 12 feet maximum depth, over 11-foot driveway: A, Crossed joists forming semihopper bin floor; B, joist with knee braces; C, trussed-beam support

VENTILATION

In some localities and during some seasons it is not possible to leave corn in the field until it has dried out to a safe moisture content. To avoid spoilage, excess moisture must be removed soon after the corn has been cribbed. Removal of moisture depends largely on air movement. Therefore the width of the crib and the provisions for ventilation should be suited to the climate. When the corn is soft, the ears must be cleanly husked so that husks or silk will not interfere with the passage of air through the mass of corn. Normally the greatest spoilage is found below the emptying point of the elevator spout where silks, shelled corn, and other débris tend to lodge and check circulation of air. For this reason as much as possible of the shelled corn should be removed before the corn enters the crib. Some portable elevators have screens that let this material fall outside the crib. The higher the crib, the greater the proportion of corn that will be shelled in filling.

Adjacent buildings sometimes interfere with air circulation around the crib. Tight sheds built against the side of the crib (fig. 3) decrease the rate of drying, but open sheds like that shown in Figure 23 are not objectionable. Placing the building broadside to the prevailing winds and leaving driveway doors open speeds up the drying.

Natural ventilation is inadequate for corn stored in tight bins except perhaps in territory near the southern or southwestern borders of the Corn Belt, where corn usually is reasonably dry when stored.

If the bins above the driveway are not needed for small grain, they can be converted for storage of corn by removing some of the floor boards and putting ventilators through the centers of the bins. Soft corn requires more ventilation than dry corn.

Suggested forms of ventilating flues in corncribs are illustrated in Figure 24. Forms A, B, D, and E are built the full length of the crib and full height of the corn pile. They divide the storage space so that shelling doors are needed on both sides. In long, high cribs the tops of the flues should be braced to the crib walls. Form A may be used in either grain bin or corncrib, as may G if it is closed along the top edge. Forms B, C, and E are commonly used where large air circulation is needed, as in pop-corn cribs; C is stronger than E; form F is especially suited for masonry crib; forms G and H are used as temporary flues across the crib and when placed at frequent horizontal and vertical intervals through the corn, they facilitate quick dissipation of the moisture, yet are not expensive. Making these flues slightly shorter than width of the crib and placing the ends of alternate flues against opposite walls probably increases the circulation of air. Draintile may be used as horizontal ducts across the crib at several heights.

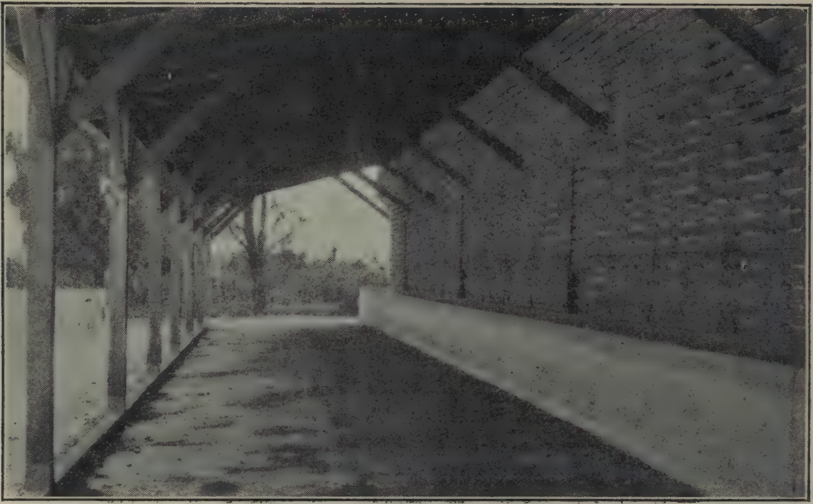

FIGURE 23.—An open feeding shed adjoining corn storage does not obstruct ventilation of crib

Much trouble in obtaining proper ventilation in large masonry or metal cribs has been experienced. Since these cribs are often 20 feet or more wide on each side of the driveway, it is necessary to provide interior ventilating flues which are sometimes 25 feet or more in height. In such buildings the flues must be practically self-supporting, as it is difficult to brace them to resist the movement of corn. Form F (fig. 24) is best adapted for use in such cribs, and generally is braced to the wall only at the plate line. The diagonal slats serve as braces and add the necessary stiffness to the flue. The spreading base anchors the bottom of the flue and gives it stability. This flue should have a long life.

Roof ventilators such as are shown in Figures 9 and 21 may be left open during stormy weather and thus lessen the number of trips to the top of the crib to open or close windows. This advantage is important in high cribs.

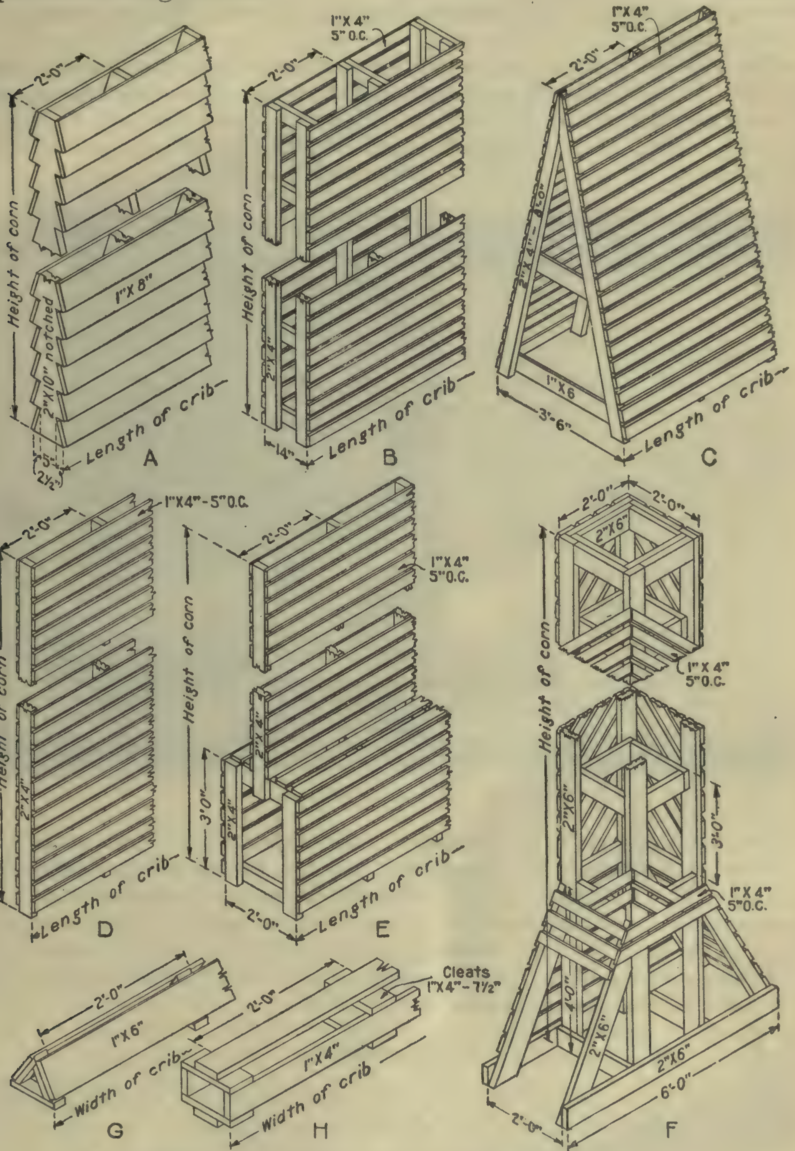

FIGURE 24.—Suggested forms of ventilating shafts

Corn-drying racks (fig. 19, B) are often useful in drying out soft corn. The racks hold the corn for a few days where the air may circulate readily through it before it is dumped into the crib below. Corn husked by machine can not be handled fast enough by this method.

It may be necessary to use fans and heated air to save soft corn. The combination of a warm-air furnace, a power fan, and ventilating ducts has been used successfully in Iowa and Illinois to dry soft corn. A silage blower may be used in an emergency, but is wasteful of power; a more efficient type of fan can be obtained for permanent installation.

The cob holds a larger portion of moisture than the kernels when the corn is first stored, and both dry slowly. For this reason continuous circulation of air at low velocity is most efficient in drying the corn. Fan ventilation is most efficient if the crib is tight and the direction of the air current is occasionally reversed.

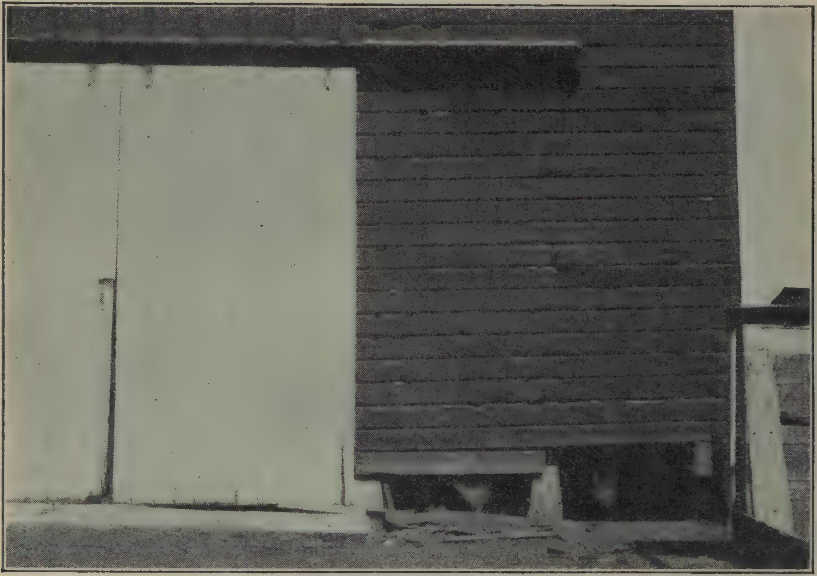

FIGURE 25.—Crib walls damaged by rats

Heavy building paper, tacked on the sides of the crib with lath, helps to confine the air currents as they are forced through the mass of corn. Warmed air will absorb more moisture than unwarmed air, and though high temperatures may hurt germination, this is of little importance with corn for feeding. Corn for seed is more susceptible to damage from heat than are wheat and other small grains, but seed corn should not be dried in the crib.

RAT PROOFING

Rats and mice sometimes cause the loss of a fourth or a third of the corn held overwinter,[5] and also do much damage to cribs. (Fig. 25.)

The use of concrete in the construction of foundations and floors is a great aid in excluding rats. Wooden floors built a few inches off the ground furnish harborage for the pests and if the crib is set too close to the ground, rats in burrowing will pile moist earth against the floor joists and sills, often causing early rotting and failure.

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[5] Information on safe measures to use in eradication of rats and mice is given in Farmers' Bulletin 1533, Rat Control.

Heavy wire netting of ½-inch mesh, carried entirely around the crib to a height of 2 feet from the top of the foundation, with an 8-inch strip of galvanized iron just above the netting, will keep rats from getting in through the crib walls. The netting and strip should be carried around the doors and door frames as shown in Figure 2. A wide metal strip will serve the same purpose. (Fig. 12.) Old cribs can often be rat-proofed in this manner at little expense. Masonry and metal cribs offer good protection against rats.

ELEVATING MACHINERY

Most cribs with a capacity of 1,000 bushels or more should have provision for elevators that will handle ear or shelled corn and small grain. The type of elevating machinery to be installed should be selected before the crib is built, and manufacturer's catalogues and layouts should be consulted for space requirements.

Portable elevators may be used with almost any type of crib. In many cases an upper section of the elevator is set permanently in one position on the roof (fig. 3), and housed against the weather. This is practical where the corn can be spouted to all parts of the crib from one cupola. Portable elevators generally have rated capacities of from 250 to about 500 bushels per hour, elevating the grain by drags or scraping bars on an endless chain. The upper end of the leg is provided with a screen that permits the shelled corn and dirt to drop out before reaching the crib. Use of a portable elevator requires space at the side of the crib and a convenient driveway to it.

If the elevator is inside the building, space and clearance must be provided for the wagon jack or dump, the receiving hopper, the elevator leg, and the delivery head and its spouts.

Cross conveyors such as were used in old style long cribs consume an excessive amount of power and give trouble when chains clog and break.

Stationary elevators may be equipped with receiving hoppers like those used on portable elevators or may have a pit and a dump log. (Figs. 26, A, and 27.) With a dump log the headroom required in the driveway is about 2 feet less than that required with a lifting jack. The dump log and pit, however, are difficult to keep clean and free from rats and mice. The best dump logs are built of seasoned planks bolted together, and with space for air to circulate under them to avoid early decay. (Fig. 27.)

Deep receiving pits in corncribs are hard to keep clean and dry and are therefore undesirable except where large quantities of grain must be unloaded quickly to avoid delaying the wagons while the grain is being elevated. Shallow pits with the receiving hoppers placed under the driveway floor are preferable. No pit is needed if the elevator can be started whenever a load is brought in. Receiving pits should be grain tight so that loose grain will not accumulate in inaccessible places.

If the aboveground hopper is used (fig. 26, B) the overhead clearance should be at least 11½ feet to allow raising the front end of the wagon with the lifting jack. The best jacks are now provided with brakes and clutches or similar mechanisms to control the angle of tilting and the rate of grain flow from the wagon, and with safety

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Usage

devices to hold the wagon in any position. Thus the grain flow may be regulated to suit the capacity of the elevator.

The elevating mechanism of inside stationary elevators consists of steel buckets or cups fastened to an endless belt or chain composed of malleable links. The ordinary open-hook links are not so strong as steel-pin links, and they wear faster because dirt gets into the joints more readily. For ear corn the cups should not be smaller than approximately 7 by 7 by 16 inches. For small grain smaller sizes may be used.

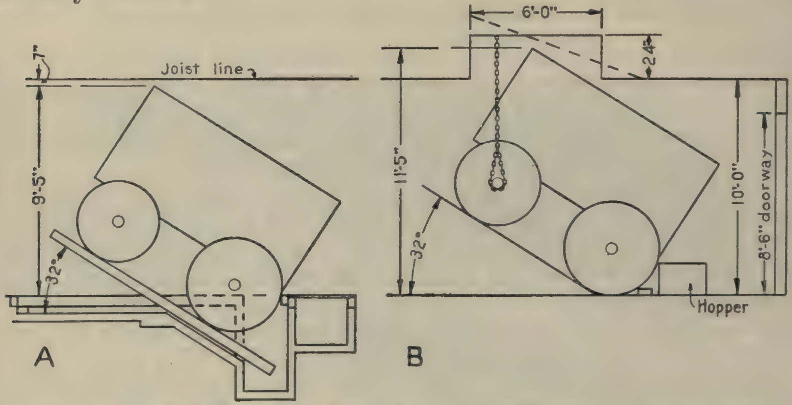

FIGURE 26.—Headroom needed with dump logs and overhead wagon hoist: A, For dump log and shallow pit; B, for overhead hoist with a movable receiving hopper. Bin space may be saved by placing joist as shown by either solid or dotted lines

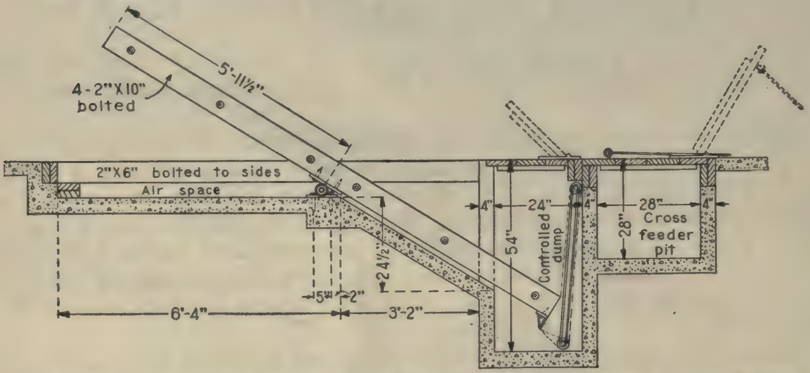

FIGURE 27.—Dump log with shallow pit; note air space beneath log and rat-tight concrete inclosure around pit and log

The elevator leg usually rises straight into the cupola, where the grain is dumped into the delivery head to be spouted to the various parts of the building. Figure 28 shows an arrangement in which the elevator leg is not vertical. This permits a smaller cupola, but increases the power required by the elevator and the wear of its parts in operation. The upside and downside of the elevator may be boxed in one housing about 22 by 26 inches at one side of the driveway (fig. 16) or they may be separated and placed as convenient.

Common arrangements of the delivery head are shown in Figure 29. Common types require a space approximately 4½ feet high and 5½ feet or more wide. The delivery spout should have a drop of at least 7 feet in 10 feet of run, for delivery at the farthest point of the crib. A much steeper slope should be used for filling most of the crib.

For ear corn the spouts are 16 inches in diameter. The first section is made full circle and the remainder of the spout is made up of detachable sections of telescoping, one-half or three-quarter circle spouting in order to decrease the weight and the labor of handling. The three-quarter round spouting is stronger than the half circle. Lengths of delivery spouts range from 16 feet for cribs 36 feet long to 20 feet for cribs 40 feet long. A 16-inch spout set at the angle required in filling the ends of the crib will not pass between studs spaced 24 inches center to center. Openings for the spout should be provided under the plate by cutting off one or two studs near each end of the crib. The sloping bin top shown in Figure 16 also aids in delivering the corn to the crib.

Gasoline engines of three to four horsepower are commonly used to operate the elevating machinery. Electric motors should be of corresponding capacity and of dust-proof type. Either source of power should be installed with proper safeguards against fire.

OTHER LABOR-SAVING DEVICES

Corncribs are filled and emptied each year, yet often the only means provided for getting the corn out is tearing off boards. (Fig. 14.) This damages the building unnecessarily. Shelling trenches (fig. 16, A) save much time and labor when corn is to be shelled, particularly in long cribs as much as 8 feet wide. In narrower cribs shelling doors such as that shown in Figure 30, or a horizontal drag (fig. 31), are less costly. Slanting, removable boards like those shown at right in Figures 31 may also be used with hinged doors to relieve the doors of strain from pressure of the corn and to regulate the flow of corn when the crib is being emptied.

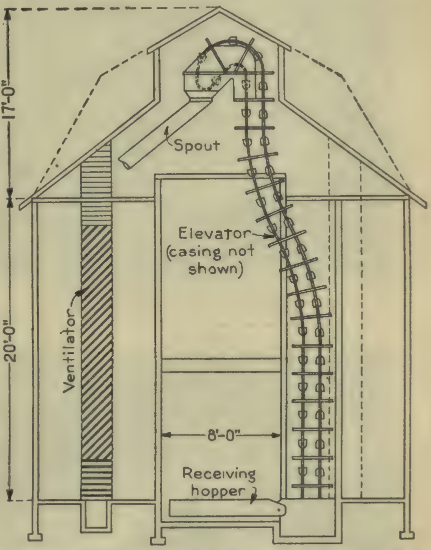

FIGURE 28.—An arrangement of curved elevator leg common in circular masonry cribs. Two-pitch roof may replace cupola

Sloping the floor of a corncrib is of no appreciable advantage in moving the corn to doors or to a shelling trench, because ear corn arches and locks together and often a pick must be used to loosen it. For the same reason hopper bins for ear corn are not satisfactory. Snapped or jerked corn flows less readily than clean-husked corn, and damp corn less readily than dry. A bottom opening for removing ear corn should be not less than 18 inches square.

Shelling trenches range from 10 to 22 inches in width according to the make of elevator drag used. Shelling doors should be at least 36 inches high. Loose boards or short cross planks are placed over the trench, and removed as the corn is shelled out. To aid in ventilating the corn the boards are sometimes spaced 1 inch apart and the trench door provided with an opening screened to keep out rats. (Fig. 8) The floor of the trench is made of concrete so that it may be easily cleaned, and to provide a smooth surface upon which to slide the sheller drag.

Shelling doors are a convenience but may weaken the crib. Figure 7 shows the failure of one crib caused by a large opening. Figure 8 shows an improved design which is more substantial, but puts a heavy strain on the top part of the frame. Figure 6 shows a precast, reinforced concrete door frame with holes through which the hoops about the crib are run to relieve the frame from the strain. The hoops are somewhat in the way when the corn is being taken out. They are sometimes cut off and firmly anchored to the frame if the latter is sufficiently reinforced.

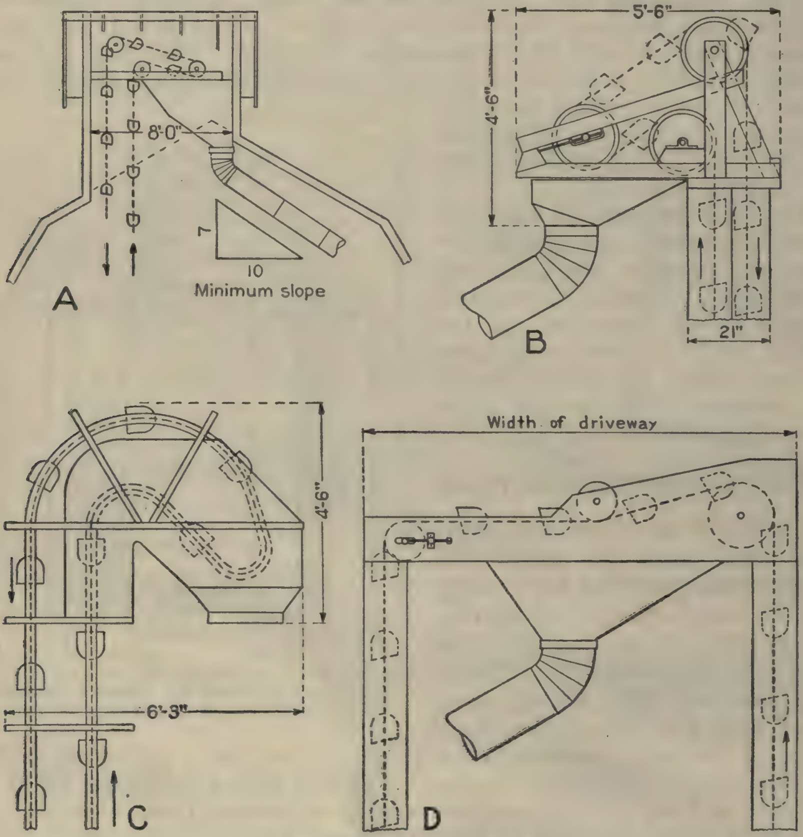

FIGURE 29.—Elevator-head installations: A, Elevator head in offset cupola; B, minimum dimensions for chain-type elevator; C, minimum dimensions for rack-type elevator; D, up and down lines of buckets separated by driveway

On most Corn Belt farms a large portion of the corn is fed to livestock. Figure 23 shows an arrangement which permits great saving of labor and time in feeding.

Figure 32 illustrates satisfactory stops or stays for large sliding doors. These consist of 1-inch iron bars bent as shown and set in the concrete floor. They are not easily injured by wagons or tractors

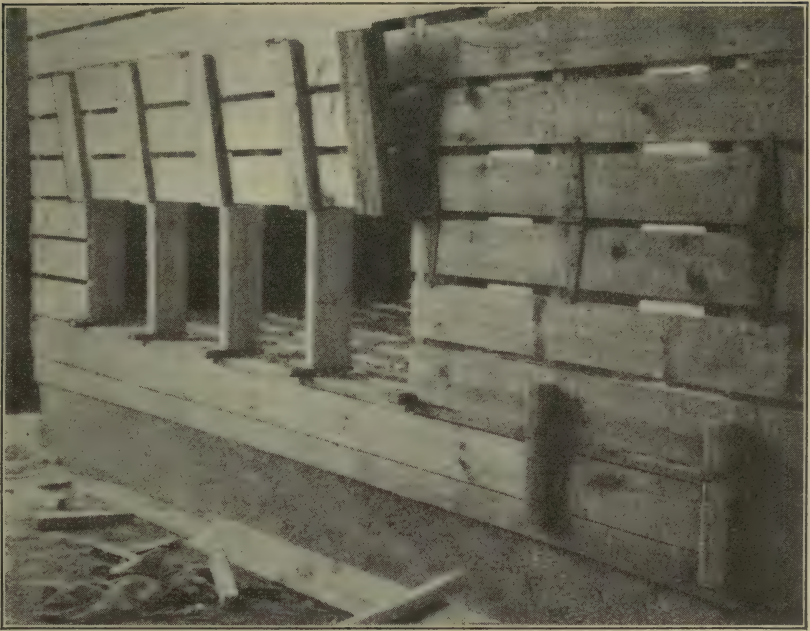

FIGURE 30.—Shelling doors held closed by wedge blocks in strap irons fastened to studs

FIGURE 31.—Sheller drag in driveway of double crib, placed to deliver corn to the elevator to be spouted to cribs or sheller

running over them. Several forms of garage door hangers are available for sliding doors that open inward. A small hinged door in a large sliding door (fig. 21) is convenient.

ACCIDENT PREVENTION

Chains, gears, pulleys, and revolving shafts located where persons or stock pass close to them, should be guarded so that clothing, hair, or members of the body will not be caught in them. Shafts and gears near a ladder should be particularly well protected. Ladders should be safe, for many trips must be made to the top of the crib to adjust spouts, to oil or adjust machinery, and to open or close ventilating windows. The rungs should be strong and mortised or let into the rail, and there should be ample space for handhold and foothold. Using the elevator buckets as a ladder involves risk of a fall as well as damage to the buckets. Ladder holes should be at least 22 inches square. Climbing is easier, and machine parts or other heavy loads may be carried to the top of the crib with less risk, especially in high cribs, if there is a smooth wall for the climber to rest his back against. Manlifts or small platform elevators are now being used in some of the larger cribs and are very convenient. Hinging the lower section of a stairway, as is commonly done, with fire escapes, will many times prevent small children from climbing in dangerous places.

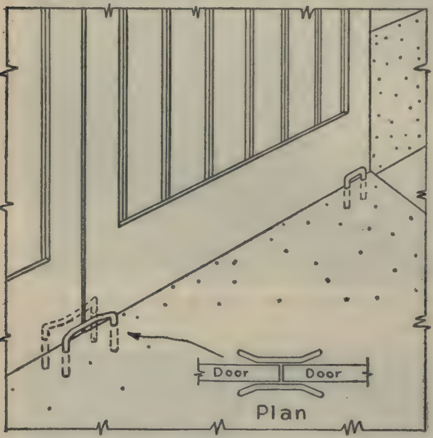

FIGURE 32.—Substantial homemade sliding door stay made from 1-inch iron rod

Where much feed grinding is done, the motor should be inclosed or dust-proof. If a gasoline engine is used, it should be placed outside the building or inclosed in a room lined with metal and properly safe-guarded against fires.

Injury to men emptying the crib, as well as to the cross bracing, may be caused by falling or sliding corn if precautions are not taken. Undercutting the pile is dangerous. The corn should be moved down steadily from the top of the pile.

PLANS AVAILABLE

The plans and illustrations shown in this bulletin may be modified in dimensions, arrangement, and details of construction. Complete working drawings for the cribs shown in Figures 2 and 16 may be obtained from the Bureau of Agricultural Engineering, United States Department of Agriculture, Washington, D. C. Information on costs of labor and material, which differ with time and place, can best be obtained from local carpenters or builders.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1702

PREPARING PEACHES FOR MARKET

PEACHES ARE GROWN commercially throughout the United States under a wide range of conditions. There are important producing areas in the Southern, North Atlantic, North Central, and far Western States, and a large part of the commercial crop must be shipped long distances to market.

The peach is a highly perishable fruit. To avoid severe losses caused by poor condition when placed on the market, proper methods and care are necessary in harvesting, handling, grading, packing, and shipping.

Losses to growers and shippers often result from picking the peaches too green or allowing them to remain on the tree too long. Damage to the fruit—with consequent loss—is often caused by bruising, caused by the use of improper methods of handling and loading. Good construction of the packing house and the use of good sizing and packing equipment facilitate the preparation of peaches for market.

Standard grades are widely used in packing peaches and their use has many advantages.

This bulletin describes the methods that have been successfully used in preparing the peach crop for market, and gives information and suggestions to growers on improving their own methods.

This bulletin is a revision of and supersedes Farmers' Bulletin 1266, Preparation of Peaches for Market.

Washington, D. C. Issued April, 1933

PREPARING PEACHES FOR MARKET[1]

By J. W. Park, *Agricultural Economist, Division of Fruits and Vegetables, Bureau of Agricultural Economics*

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HARVESTING

THE CONDITION of peaches upon their arrival in the markets depends largely on the care and method of handling them and on the stage of maturity at which they are picked and shipped. The peach ripens so quickly that it may change, in three or four days, from a condition of immaturity to one of overripeness. It is to the growers' advantage to make every effort to pick the peaches at just the right time and to prevent injury to the fruit by careful handling and by using proper methods, utensils, and equipment.

TIME OF PICKING

Picking at the right time is more important in harvesting peaches than in harvesting most other fruits, in order to avoid the serious losses that are now annually sustained by many growers through shipping immature or overripe fruit.

Peaches should reach the market nearly ripe enough for eating but firm enough to be handled through the ordinary channels of trade. The best degree of ripeness at picking time to insure this condition depends largely on the method of shipment to market, the weather conditions, the variety, and the speed and method of handling.

Peaches intended for shipment by motor truck to near-by markets are often allowed to practically ripen on the trees, with satisfactory results. In such instances the fruit is usually trucked to market during the night for early morning sale. Unless it moves rapidly through the trade channels to the consumer or is peddled direct to the consumer there is likely to be heavy loss through overripeness.

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[1] This bulletin is based on Farmers' Bulletin 1266, Preparation of Peaches for Market, by H. W. Samson, formerly specialist in standardization, Bureau of Agricultural Economics. Acknowledgment is made of the assistance rendered by field representatives of the Division of Fruits and Vegetables who supplied specific information relating to various producing areas.

Peaches that are to be shipped a considerable distance in refrigerator cars should be picked before they are ripe enough for eating. In some important producing areas, as in the Middle Atlantic and South Atlantic States and North Central States, a general rule is to pick the fruit about 36 to 48 hours before it would reach the proper maturity for eating if left on the trees. This rule is based on average weather conditions. Fruit that has been maturing slowly during a period of cool weather will ripen at a much more rapid rate if the weather turns hot, whereas cool weather will retard the ripening.

One widely used indication that the fruit is about ready to pick is the change in the ground color, from the green that is indicative of immaturity to a light yellow or lemon yellow in the case of yellow-fleshed varieties or to a creamy white in the case of white-fleshed varieties. There is a swelling of the flattened sides of a peach just prior to maturity and some growers defer picking until this occurs.

The stage of maturity at which the peaches should be picked differs to some extent with the variety, as some varieties deteriorate very quickly after reaching maturity and others more slowly. Some ripen unevenly and others have a tendency to drop as they approach maturity. For example, the Hiley, an important commercial variety in the South, ripens more slowly than most other early or medium-early varieties and may be left on the tree longer after it begins to show some indications of maturity. The Elberta, the most popular and widely grown commercial variety and one of the best varieties for long-distance shipment, must be picked promptly after reaching a certain stage of maturity, to avoid loss from dropping.

Fruit that is to be handled carefully and rapidly and is to be precooled before shipping or placed in the refrigerator car within a short time after picking can be allowed to reach a more advanced stage of maturity than if it were to stand for a considerable time in the orchard or packing shed on a warm day before being placed under refrigeration.

In an effort to obtain the high prices frequently paid for the earliest shipments from the South, peaches are sometimes sent to market when they are so green that they shrivel instead of ripening; instead of high prices the shipper receives low prices and may suffer a loss. Unfortunately these losses are only one part of the injury done to the industry through this practice, as the consuming public soon loses confidence in the quality of the fruit, and this loss of confidence is reflected in the price of all peaches on the market for some time.

In picking, the trees must be gone over a number of times if the fruit is to be harvested at the proper stage. In some areas, under average conditions, three pickings are usually made. Under other conditions more pickings are necessary and occasionally fewer than three will suffice. Although the ideal stage of maturity for picking should be kept in mind, there are usually many practical difficulties which make it impossible to pick all of the fruit at just the right time, especially if crops are very large. Under such conditions the best practice is to include in each picking the fruit that would be improved somewhat in shipping quality by remaining on the tree for a short time. If any variation is necessary from the rule, it is better to pick slightly too green than too ripe, for although immaturity impairs the quality, overripeness may and frequently does result in a total loss of the shipment.

CARE IN PICKING

Great care must be used in picking such a tender fruit as the peach, to prevent bruising and consequent deterioration and loss. Damage to fruit frequently results from careless handling by pickers in tossing the peaches into baskets on the ground or pouring them from the picking utensils into the orchard boxes or baskets used for hauling the fruit to the packing house. This sometimes occurs even in orchards where the fruit is handled with scrupulous care after arriving at the packing house. Consequently the need for closer attention to the picking operation can not be too strongly emphasized. Badly bruised fruit is practically worthless for shipping. Furthermore, not only is the cost of sorting increased by its presence, but since the bruises are not always readily detected at this time, much injured fruit that is susceptible to the entrance of decay organisms and that endangers the sound fruit may be packed.

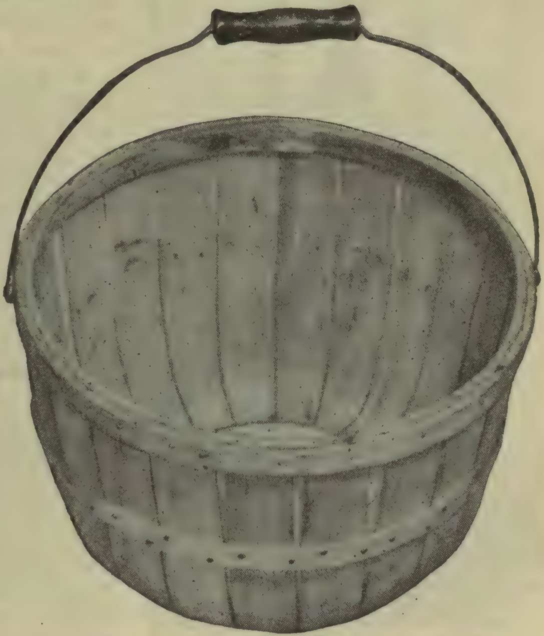

FIGURE 1.—The ⅝-bushel round stave basket is a popular picking container in the South

To provide a check on the work each picker should be required to place a ticket bearing his number in each field box or basket of peaches which he has picked, and a penalty should be imposed for failing to do the work well. The grower or a competent foreman should inspect the picked fruit frequently, in the orchard, to see that the work is properly done.

PICKING UTENSILS

Various types of picking utensils are in use. In the South Atlantic States the ⅝-bushel round stave basket is commonly used. (Fig. 1.) Drop-bottom bags and buckets are used by some growers in various areas, including the Middle West and Rocky Mountain States. Hampers and bushel baskets are also used to some extent.

If the ⅝-bushel basket is used in picking, it is also used in hauling the fruit to the packing house. This avoids the danger of bruising the fruit when it is poured from one container to another; this object is particularly important in handling the more tender varieties. The ⅝-bushel baskets are usually made of oak or elm staves and are durable and satisfactory for hauling the fruit. An objection to their use is that when used in picking they do not permit the free use of both hands.

In some districts ordinary galvanized metal buckets are used in picking and the peaches are usually hauled to the packing shed in these buckets.

Picking baskets lined with corrugated paper have been used to advantage in certain sections, as in northern Ohio. They prevent some bruising.

Drop-bottom picking sacks are employed to a considerable extent in the Middle West and in many of the large orchards of Texas and Arkansas, but with few exceptions they are used only in harvesting the Elberta variety.

Drop-bottom buckets (fig. 2), operating on the same principle as the drop-bottom picking sacks, are also used, but both sacks and buckets of this type are open to the objection that the fruit must be transferred to other containers, such as field boxes or baskets, for hauling to the packing houses, and care is necessary in this operation to prevent bruising. (Fig. 3.)

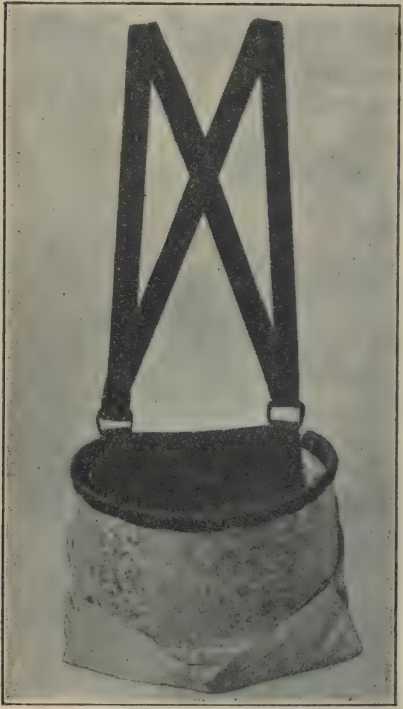

FIGURE 2.—This type of drop-bottom picking bucket has a padded rim to prevent bruising the fruit. As the bottom of the bucket is slightly larger than the top, emptying is facilitated

In the Pacific Northwest galvanized-metal buckets both with metal bottoms and canvas drop bottoms are used. The all-canvas picking bag is also in use in this region.

The 16-quart and 20-quart hampers are popular picking containers in the Middle and North Atlantic States and in other sections where they are employed as shipping packages, but frequently they are very frail and begin to break after being used for a few days in the orchard. To avoid this loss some growers send them to the orchard only once for picking, and then use them as shipping packages. Because of its small base, the hamper often upsets when filled, but this can be avoided if the pickers use a little care in placing it.

In some instances hampers and baskets have been used to much better advantage by carrying them under one arm, supported by a strap passing over the shoulder. The strap is caught into each side of the basket by heavy wire hooks. The picker can use both hands and the speed of the work is increased to a marked degree. The temptation to put the basket on the ground and toss the fruit into it is also avoided. The straps should be wide enough not to chafe the picker's shoulder and the hooks should be large enough to be easily attached and released.

HAULING FROM THE ORCHARD

Various types of trucks and wagons are used in hauling peaches from the orchard to the packing house. In general, wagons used for this purpose should be equipped with springs to reduce the amount of bruising, although where the soil is sandy, wagons without springs have been used successfully. The most convenient type has a low bed to facilitate loading and unloading and movement under the trees in the orchard, but on account of the relatively heavy draft many growers prefer wagons of the usual height, equipped to accommodate either one or two layers of baskets. Where two tiers of baskets are hauled the wagon or truck is provided with crosspieces about 20 inches above the bed, and loose boards are laid on these crosspieces to support the second tier of baskets. A deck may be made, divided in the middle and equipped with hinges, so that it can be raised while the lower tier is being loaded and unloaded. It should be built in lattice form, of light strips, and supported, when down, by small posts. Where the ground is fairly level, wagons equipped with platforms, known as "flats" (fig. 4), are used for hauling large loads so that two tiers of baskets will not be necessary, and smaller flats are sometimes used for hauling between the tree rows. In the Rocky Mountain States sleds are sometimes used in hauling from the orchard.

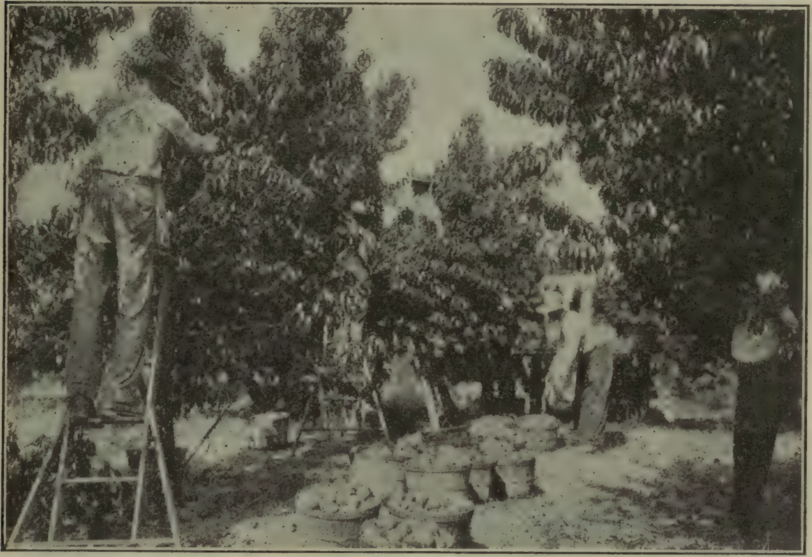

FIGURE 3.—In this orchard in the Middle West drop-bottom picking utensils are used and the peaches are then transferred to baskets for hauling to the packing house

In large orchards, in which the distance to the packing house is considerable and the rows of trees are close together, it is often necessary to use small 1-horse wagons for hauling the peaches out to the main roadways, where they are transferred to trucks. These small wagons preferably should be of the cut-under type. Rehandling is objectionable, but under certain conditions it may be better than driving a 2-horse wagon between the trees. In some large orchards, as in Delaware, wagon trains pulled by tractors have been used in hauling peaches from the orchards.

The operation of hauling peaches to the packing house should be carefully organized. Enough vehicles should be employed to haul the fruit out of the orchard soon after it is picked without the necessity of handling it so rapidly as to cause bruising. Unless the hauling is well organized and efficiently done the fruit may remain in the orchard unnecessarily long or may be damaged by rough handling. Regular deliveries at the packing house are desirable so that the grading and packing force will not be alternately idle and rushed. It is a serious matter to the grower to have the whole packing crew idle and waiting for peaches to be hauled from the orchard. In a large orchard a capable foreman should be in charge of the hauling.

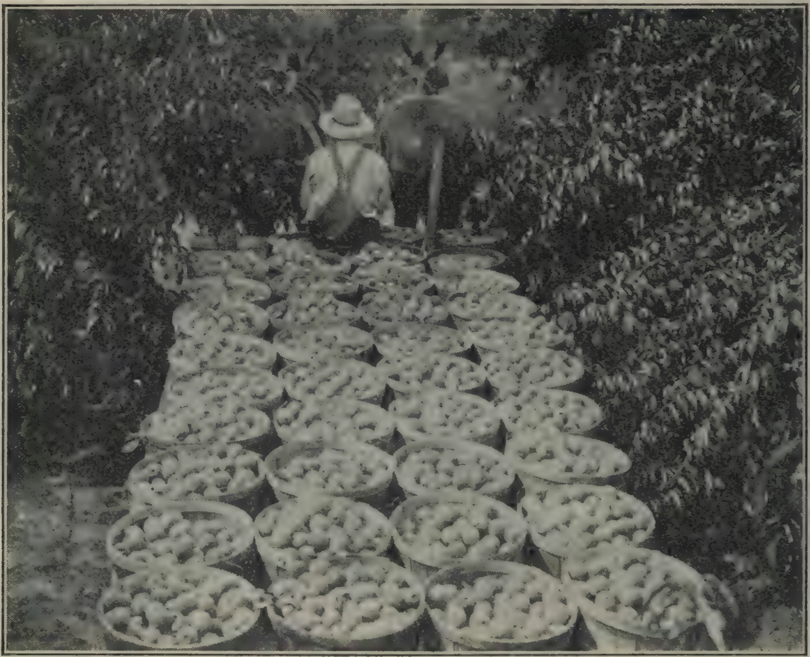

FIGURE 4.—A wagon equipped with a wide platform known as a "flat" is convenient for hauling peaches to the packing house

PACKING HOUSES

Peach-packing houses differ in type and construction in different producing areas and within the same area. In most of the important shipping sections there are well-constructed packing houses, and also cheaply built packing sheds, often without floors. In some sections, particularly where weather conditions at harvest time are generally favorable, some packing is done in the open.

Packing can be done more efficiently in a conveniently located, well-arranged, and fully equipped packing house. (Fig. 5.) The expense that a grower is justified in assuming in building and equipping a packing house depends on individual conditions, such as size and productivity of orchard and method of marketing. Growers who have a small volume of production, or who have nearby market outlets, or who sell the fruit orchard-run to merchant truckmen may not be justified in large outlays.

Central packing houses where growers bring their fruit to be packed are in use in some districts. In the State of Washington it has been the general practice to pack peaches on the ranches, but recently there has been a tendency toward the use of central packing houses.

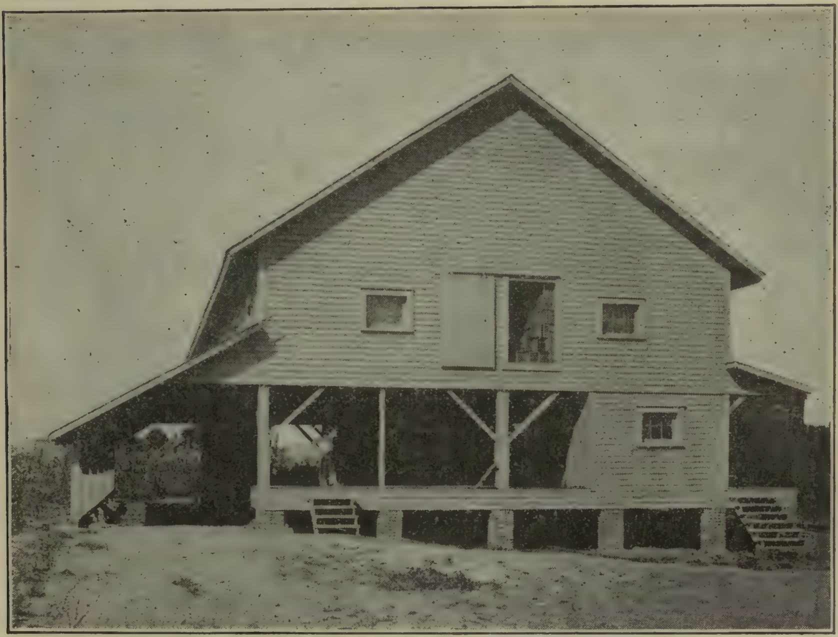

FIGURE 5.—A typical Georgia peach-packing house

LOCATION

If the crop is to be shipped by rail and the orchard is located on a railroad or a spur track, the packing house should be built alongside the track in order to do away with the necessity of hauling the packed fruit. Many packing houses are located along railroad tracks several miles from the orchards and near villages. The fruit is hauled from the orchard in trucks. The advantages claimed for this system are that the packed fruit can be loaded directly on the cars and that packing-house employees need not be transported to the orchards. In such an arrangement it is necessary to take care that the peaches are not damaged by bruising in hauling them from the orchard to the packing house.

If the peaches are packed in an orchard with no railroad siding, the principal consideration is to reduce to a minimum the distance the loose fruit must be hauled, as peaches are more likely to be bruised when hauled loose than after being packed. In a flat country, like the Fort Valley section in Georgia, the most desirable location is near the center of the orchard, or at a central point if the output of several orchards is packed through one house.

CONSTRUCTION

A common type of packing house in the South and in some other areas is a frame building, two stories high. The upper story or loft, where crate materials and baskets are stored, is inclosed, and the lower floor, where the packing is done, is open. These houses are usually 35 to 60 feet wide and from 60 to 150 feet long. The fruit moves across the short dimension of the house during the packing process, so that operations in a house less than 35 feet wide are likely to be hindered by insufficient space for loose and packed fruit. Baskets or crate materials from the loft are usually supplied to the packers on the lower floor by means of chutes, which run either parallel to or at right angles to the packing benches.

The first floor should be built at approximately the same height as a truck or wagon bed, or the floors of the refrigerator cars if the house is on a railroad siding. This height facilitates handling the fruit and permits good ventilation. The packing-room ceiling should be about 10 feet high. Most packing houses have covered driveways, which serve the excellent purpose of protecting the fruit while the wagons are being unloaded and loaded, but which have the disadvantage of cutting off a part of the light.

The various types of packing houses include some that are inclosed on three or four sides, in which case windows should be used. Some are 1-story structures. Galvanized-iron or tin roofs without insulating material underneath often permit extremely high temperatures in the packing houses in the hot weather.

The size and output of packing houses vary widely within most areas. In Illinois a common size has two sizing machines and a capacity of 2 to 8 or 10 cars a day. In Arkansas there is a wide variation in size and type; some of the larger houses have a capacity of about 20 cars a day.

In some sections growers who produce other fruits, like apples and pears, use the same house and some of the same equipment for all packing operations. A type of packing house used to some extent in northern Ohio is about 175 feet long and 36 feet wide, with a 10-foot covered driveway. The sizing machines are placed in pits 14 feet square and 3 feet deep. The baskets are packed in these pits and the packed fruit is set out on the main floor by the packers.

LIGHTING

Proper light for grading operations is highly important. Even in houses with open sides the lighting facilities are sometimes inadequate especially when packed containers are stacked high on one side of the house. This difficulty might be overcome by putting in hip-roofed skylights and light shafts over the sorters, where the additional illumination is most necessary. If the construction of the house can not be changed without excessive cost, the interior should be painted white. Some houses are equipped with electric lights over each bin. Such lights are essential when night work is necessary during the height of the shipping season and may be desirable on cloudy days.

PACKAGES

The most suitable package to be used by a section or by an individual grower in marketing peaches, depends upon the varieties grown, the method of transportation to market, the relative costs of the packages, market preferences and conditions, and the kind of labor available. The bushel basket, the 6-basket carrier, the ½-bushel basket, the 16-quart and 20-quart hampers, and the western box are the principal containers used in marketing the peach crop. The ¼-bushel basket is also used to a limited extent.

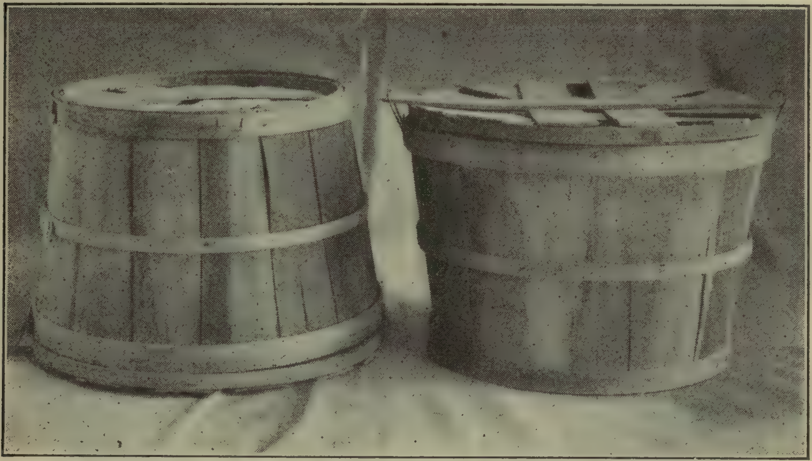

FIGURE 6.—The straight-side bushel basket is the container most used in marketing peaches

THE BUSHEL BASKET

The straight-side bushel basket or tub is the most widely used. (Fig. 6.) Bushel baskets used in shipping peaches were formerly of the rounded-bottom stave type, and this type of basket is still used to some extent. The straight-side basket has become more popular because it is more rigid and is well adapted to use with mechanical packing devices. Shipments to middle-western markets from the South are mostly in bushel baskets that are popular in the Middle West. They are suitable for the Elberta, the principal commercial variety in most peach-growing areas.

The bushel basket has been used almost exclusively in the middle-western producing areas, in western New York and in Texas and Oklahoma, but the ½-bushel basket has recently come into general use. In Georgia and the Carolinas the bushel basket is generally used, particularly for the midseason and late varieties. It is the principal container in Tennessee and the Middle Atlantic States and in the Rocky Mountain States.

A corrugated paper cap is placed under the cover to protect the fruit from bruising. The cap is placed with the smooth side next to the fruit, and should be slightly larger than the cover itself so that the peaches around the outside of the top layer will be protected from injury by pressure of the cover.

The bushel basket is cheaper than the 6-basket carrier and can be packed more rapidly and cheaply with the aid of mechanical packing devices.

THE 6-BASKET CARRIER

The 6-basket carrier was used almost exclusively in Georgia for 25 years, but has given way to a considerable extent to the bushel basket. It is widely used in the Carolinas and to some extent in the Middle Atlantic States. The carrier is especially suitable for shipping the early tender varieties, including Carman, Hiley, and Belle. Peaches put up in this package are well protected, receive careful handling in packing, and are attractively displayed.

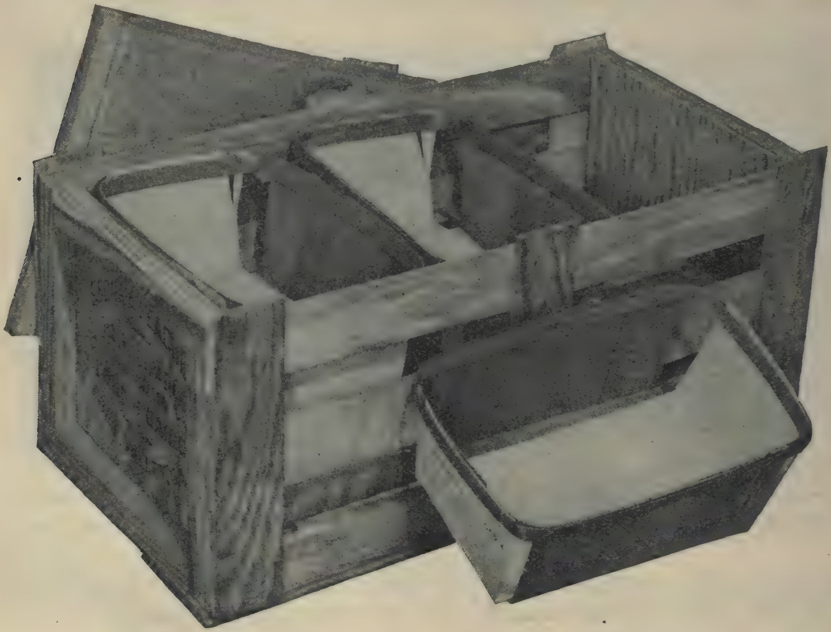

FIGURE 7.—The 6-basket carrier contains six 4-quart till baskets

The carrier contains six 4-quart till baskets, placed in two tiers, with a dividing tray to prevent the fruit in the lower tier from being bruised by the pressure from the upper baskets. (Fig. 7.) It is 22 inches long, 11 inches wide, and 10 inches deep, inside measurements, although a crate with a 10½-inch depth has been used to a limited extent in a few States, as Maryland and New Jersey. As the till baskets are the same size in crates of both depths, it is easier to obtain a high bulge to the pack in the shallower crate. However, on the

10-inch crate cleats are used to raise the lid; with the 10½-inch crate no cleats are used. A reasonably high pack is desirable to offset the settling in transit and to hold the fruit tightly in place.

To protect the peaches on the top of the package, pads made of excelsior covered with wrapping paper are placed over the fruit. These pads are sometimes sold attached to the covers, but they can be bought separately. Corrugated-paper pads are used by some shippers. Excelsior pads or cushions are recommended, as careful observations have shown that packages so equipped arrived in the market with much less bruising of the fruit.

The use of the carrier encourages more careful sorting than is commonly practiced when the fruit is packed without any definite order of arrangement. Each peach is handled separately by the packers, thus affording an added opportunity to sort out the overripe and defective specimens. The arrangement of the fruit in the basket contributes to the attractiveness of the package, and minimizes the danger of bruising. The open spaces between the baskets permit a free circulation of air and facilitate refrigeration in transit.

The principal objection to the carrier is that packing it is slower and more expensive than packing the bushel basket. In Georgia this work was formerly done entirely by professional orange and tomato packers from Florida, but local help is employed extensively now. The use of mechanical packing devices for the bushel basket and the labor situation have been important factors in bringing about the use of the bushel basket in the region where the carrier was formerly employed almost exclusively.

In the Middle Atlantic States the carrier has been used to a considerable extent as a shipping package for all varieties that are shipped before the Elberta and for a part of that crop as well. The carrier has not been popular in western New York, in Ohio, Oklahoma, Texas, and some other sections where the Elberta is the leading variety, because this peach can be shipped in bushel baskets with little injury and at a relatively small cost for packing.

THE ½-BUSHEL BASKET

One-half-bushel baskets have come into use in various peach-producing areas. These baskets are usually of the straight-side type and offer satisfactory protection to the fruit. Because of the smaller quantity, consumers frequently buy the entire half bushel as a unit.

THE ¼-BUSHEL OR PECK BASKET

In Georgia, and possibly in some other sections, a few shipments have been made in peck baskets. This is a consumer package and may have some merit in stimulating sales. The cost of containers and packing is relatively high when the peck basket is used.

THE HAMPER

Some 16-quart and 20-quart or ⅝-bushel hampers are used in the Middle Atlantic States, particularly New Jersey and Delaware. Their use is restricted largely to roadside and local sales. A few are used in shipments to nearby markets.

THE WESTERN BOX

The western box is used in shipping fresh peaches from California and Washington, and to some extent in other Western and Rocky Mountain States. Its inside dimensions are 11½ inches wide by 18 inches long, and its depth ranges from 3½ to 5 inches, but is usually from 4 to 4¾ inches. The box, which is always lidded, offers good protection to the fruit and is an attractive display package.

A lug box is also used in California and Washington. Its inside dimensions are 13½ inches wide by 16⅛ inches long and 5¾ inches deep. It is sometimes used without a lid. The lug is especially adapted to large-sized fruit, for two layers can be packed without using several cleats under the lid.

PACKING EQUIPMENT

SIZING MACHINES

In most of the important commercial peach-producing areas sizing machines are in general use, although hand sizing is still practiced extensively, particularly in the smaller orchards.

In the Georgia peach districts practically all packing houses are equipped with sizing machines. In Arkansas sizing machinery is used only in the packing houses at the larger orchards. In one district in Virginia hand sorting and sizing is practiced in slightly more than half the packing sheds. Most of the sizing and sorting is done by hand in Utah. In some areas where apples as well as peaches are grown—as in Indiana, western New York, and Colorado—apple-sizing machinery, usually with some modifications, is frequently used to size peaches. In Washington much of the sizing is done by hand, but apple-sizing machinery or special sizing machinery is used in some of the larger packing sheds.

Under ordinary circumstances fruit may be sized more rapidly and accurately by machinery than by hand and, if the volume is sufficiently large, at considerably less cost.

In the United States standards for peaches the size is based on the minimum diameter taken through the center and at right angles to a line running from stem to blossom end. Most machines are designed to size the peaches according to this minimum diameter.

Since the peach is easily damaged by rough handling, it is essential that the machine be designed to handle the fruit with a minimum amount of bruising.

Several types of sizing machines are in use. The sizing mechanism in a widely used and popular type consists essentially of a rotating roller with a rope belt parallel to the roller and moving along a guide. The roller has offsets at intervals so that the smallest peaches fall through between the roller and the rope first, and the next larger size fall after the first offset on the roller is reached. The roller rotates so as to tend to lift and turn the peaches as the moving rope tends to carry them along the roller. (Fig. 8.)

After the peaches are sized they may go into canvas or padded chutes for packing or may be transferred by canvas conveyors to shallow packing bins.

These machines frequently have 2, 4, or 6 rollers. The manufacturer claims a capacity of 2,000 to 3,000 bushels per 10-hour day for a machine of the 4-roller type. The over-all length of a popular 4-roller model, including hopper and sorting conveyor, is 24 feet with an over-all width of 40 inches.

A view of the sizing mechanism in another type of sizing machine is shown in Figure 9. The sizing mechanism consists of rollers operating in pairs. The rollers marked A are spaced at regular intervals; those marked B are mounted to swing in arcs and they cooperate with the spaced rollers to define the size of the opening. As the belt is carried forward these rollers are progressively lowered by means of the steps shown at points C, thus increasing the size of the opening through which the peaches may be discharged to the distributing belts at point D. The distributing belts carry the various sizes to the packing bins. Such machines are built in different lengths, but the most popular size accommodates 15 packers and has about 36 feet of bin space.

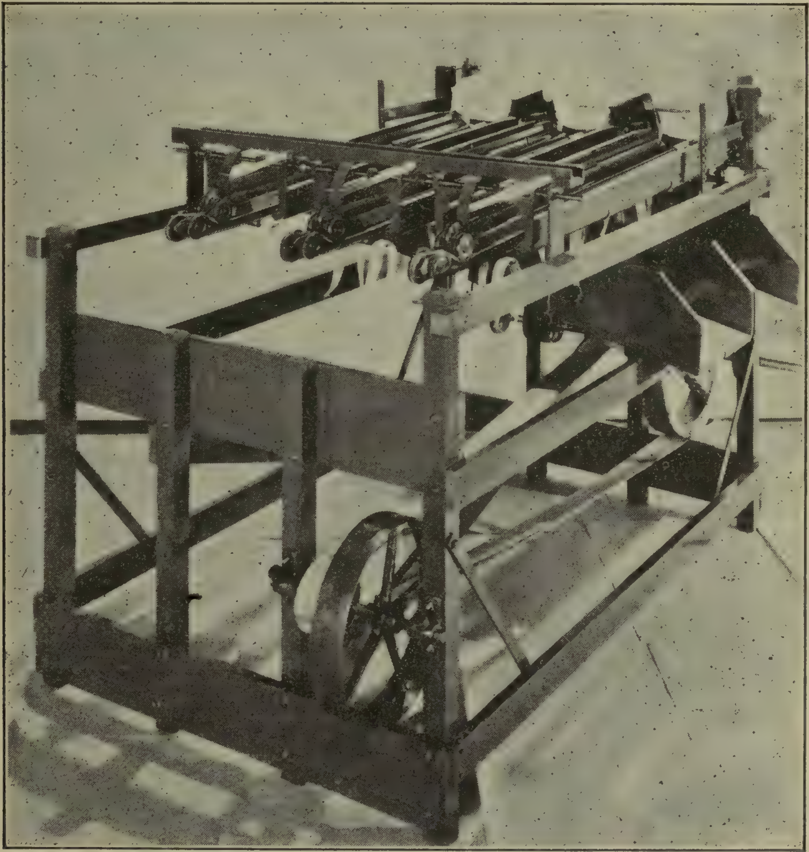

FIGURE 8.—In this type of peach-sizing machine the sizing mechanism consists essentially of rotating rollers which are offset at intervals. Rope belts moving along the side of the rollers carry the fruit forward

The United States Department of Agriculture has developed a machine that is used in various sections. This machine is described in detail in Department Bulletin 864, A Peach Sizing Machine. It does the sizing by means of diverging ropes. Apparatus employing the diverging-rope principle in sizing is used considerably in the Northwest. A few other types of sizing machines are used in various sections.

Sizing machines are equipped with conveyors which carry the peaches from the hopper, or from the place where they are transferred from the field boxes or baskets, to the sorting and sizing machine. The culls are picked off the conveyor before the fruit reaches the sizing apparatus. The most popular type of conveyor consists of rollers placed close together and at right angles to the direction in which the conveyor moves. These rollers rotate as they move along and turn the peaches slowly so that the sorters can see the entire surface of each peach and remove defective specimens. In some instances the conveyors are made of canvas belting.

Machines may be equipped with cull chutes or conveyor belts to carry away the inferior fruit. A center section of the conveyor may be divided off by strips or boards placed lengthwise and this center portion, provided with a chute at the end, can be used for cull disposal. With this arrangement sorters can remove the culls without taking their eyes off the passing fruit.

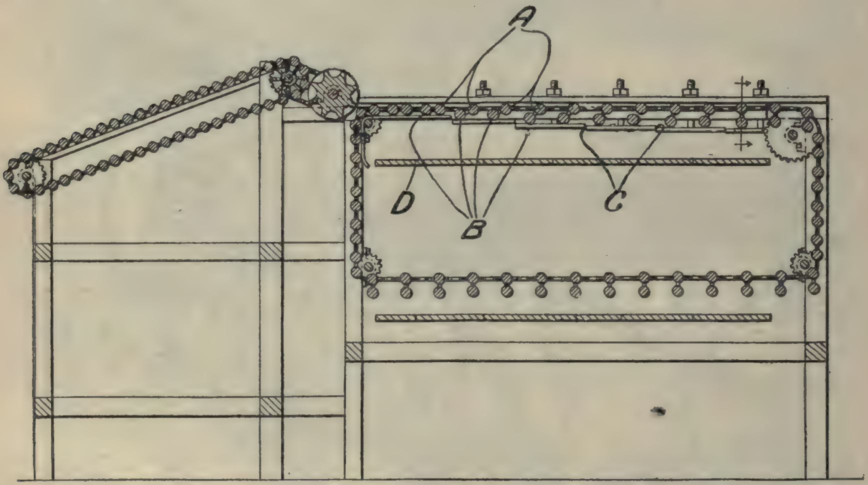

FIGURE 9.—In this type of machine the sizing mechanism consists of rollers operating in pairs. In this sectional view A and B are the sizing rollers; C marks the steps that permit enlarging the openings; and D, the distributing belt

Where two or more grades of fruit are packed, as United States Fancy, United States No. 1, and United States No. 2, the United States Fancy and United States No. 2 are picked off the main conveyor and either placed in containers beside the sorters or placed on conveyor belts to be carried to one end. The fruit thus sorted out can be sized separately.

In some sections in which considerable hand sizing is done, tables consisting of a frame that is lower at one end than the other and having a canvas top, are sometimes used. The peaches are moved from the higher to the lower end partly by gravity and partly by hand, and defective and undersized stock is removed during the operation.

DEVICES FOR PACKING BASKETS

The several devices used in packing bushel baskets have helped to bring about the popularity of this package. The straight-side type of basket is better adapted to use with these devices than is the round-bottom type. In most packing houses in districts where the bushel basket is used these devices are a part of the equipment. They are also used in packing the ½-bushel basket.

A popular type is illustrated in Figure 10. It consists of (fig. 10, A) a metal-facing form with concentric grooves or depressions spaced according to the size of the fruit to be packed, on which peaches are arranged for the top layer or face of the pack. There is also a metal packing shell which will just fit inside the basket. This shell, with a heavy paper liner inside, is placed on the facing form after the face is laid and is filled by allowing the peaches to run gently from the packing bin. The packing shell is then removed, allowing the heavy paper liner to hold the pack in place. (Fig. 10, B.) The basket is then placed down over the pack. (Fig. 10, C.)

A special device is often used to facilitate turning the packed basket to an upright position. (Fig. 10, D.) This consists essentially of two frames or racks each constructed of two metal strips bent at right angles and hinged to a crossbar at the center of a stand or table. The height of the crossbar above the surface of the stand is equal to half the height of the basket. The facing form, with the packed basket in an inverted position resting on it, is placed on the frame or rack at one end of the stand. The other rack is held tightly against the bottom of the basket. By means of this device the facing form is held tightly in place as the basket is brought to an upright position, so that the face of the pack is not disarranged. The facing form is then removed, and the basket is ready to have the cover attached. (Fig. 10, E.)

In another type of device the packing shell, instead of being solid, consists of thin metallic fingers. A facing disk, which may have a circular piece of felt in the center, fits inside the shell. (Fig. 11.) The paper liner for the inside of the basket can be eliminated if this device is used. After the face is laid and the shell is filled, the basket is inverted over the pack. The pack is brought to an upright position and the packing shell is then pulled out. While the packing shell is being withdrawn, the facing disk is held in position on the face of the pack to prevent disarrangement of the face.

Under one system of packing, the face of the pack is laid directly in the cover of the basket. A metal shell, with a heavy paper liner inside, is placed on the cover after the face is laid. The shell is then filled and the liner holds the pack in place after the shell is removed. A special press is used to bring the basket down tightly over the pack while the cover is fastened to the basket with flat hooks. (Fig. 12.) The completed pack, made under this method, is shown in Figure 13.

Under another method of packing, a basket with a removable bottom is used. The cover is attached to the basket, and if paper caps or liners are used they are put into position through the open bottom. The inverted basket should be placed on blocks or on a raised ring so that the cover does not rest flat on the table. The

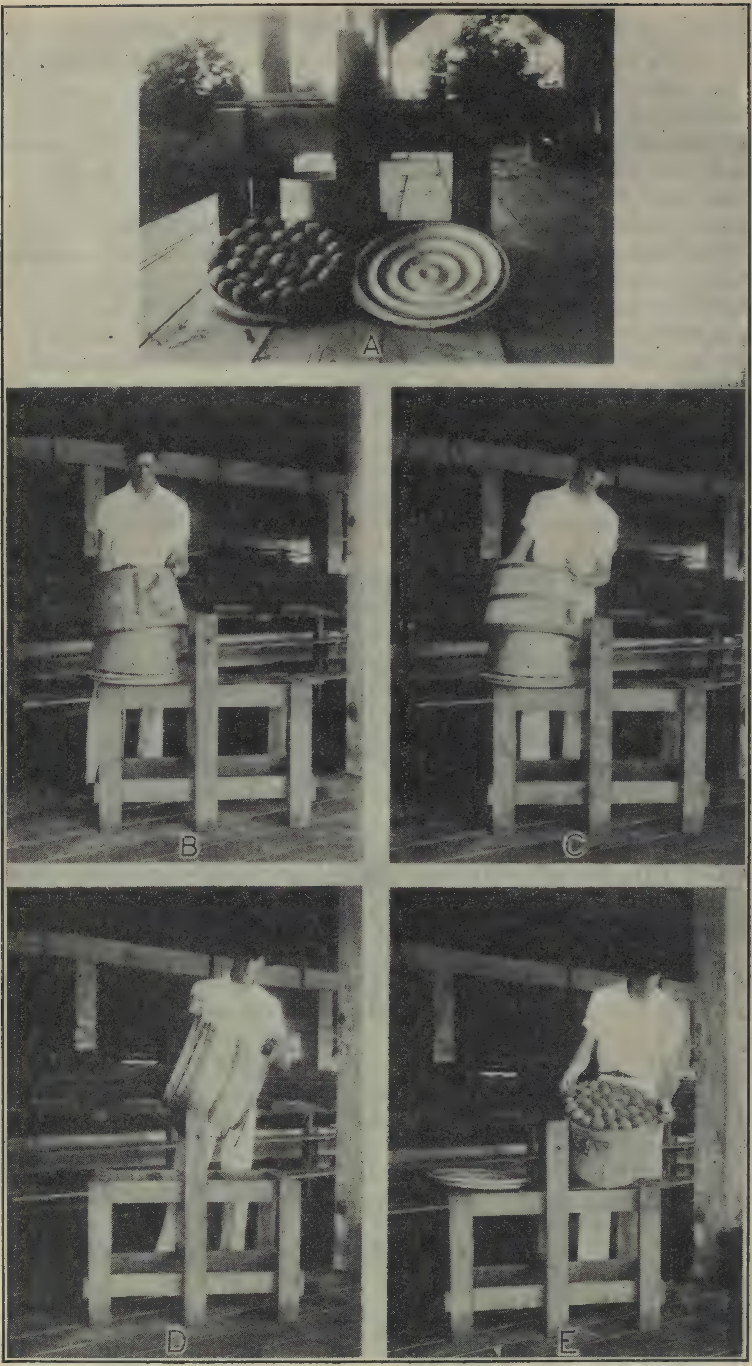

FIGURE 10.—Under this method of packing the basket, the face is first laid in a facing form (A). After the shell and liner have been placed on the facing form and filled from the bin, the shell is removed, the paper liner holding the contents in place (B). The basket is then placed over the pack (C). The basket is brought to an upright position (D). The facing form is then removed (E)

facing layer is then laid through the open bottom; it consists of uniformly sized fruit with the colored sides of the peaches placed down. The colored sides of the peaches in this facing layer will be on top when the pack is completed. The basket is then filled level full and should be shaken several times during the process. After a bottom pad is placed over the fruit the bottom of the basket is fastened on. (Fig. 14.)

MISCELLANEOUS EQUIPMENT

A few growers in various sections use devices for removing the fuzz from peaches. These machines are usually placed just ahead of the sizing apparatus. In one type of cleaning or "defuzzing" machine rotating brushes over which the fruit passes turn the peaches rapidly against suspended stationary brushes. No adjustment because of variation in size of the fruit is necessary. (Fig. 15.) In another type of fruit-cleaning apparatus which can be used for defuzzing peaches the fruit passes between rotating brushes and soft cloth buffers rotating above the brushes. In both types of machine an exhaust piping and fan create suction to remove and carry away the fuzz.

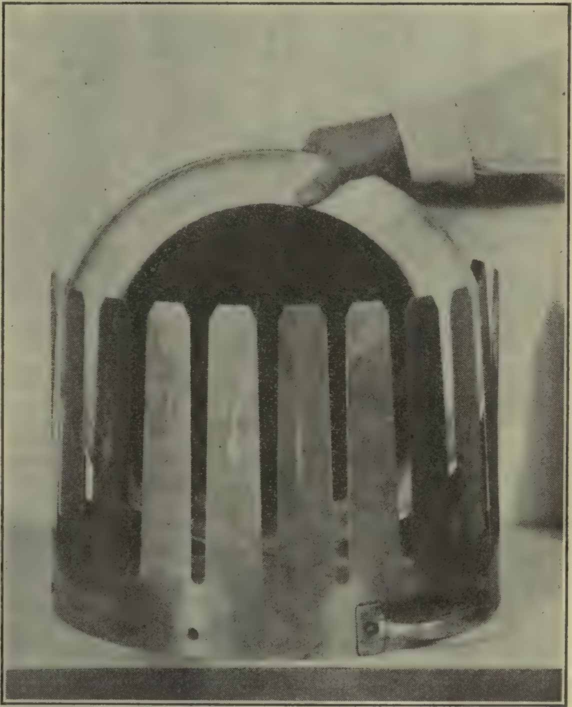

FIGURE 11.—In this type of basket-packing device, the packing shell has thin metallic fingers

The end view of a packing bench used in packing 6-basket carriers is shown in Figure 16. This bench is designed for hand sorting and sizing of the peaches from the field basket into the bin in the top of the bench. The bench upon which the crate is placed should be 27 inches from the floor. The height of the lower side of the bin is about 38 inches. The bins are about 2½ feet long and about 24 inches wide and are made of burlap, ticking, or canvas; in some instances they are supported by wire screen. All parts of the bin that are likely to cause bruising should be padded. There should be a sufficient slope toward the packer to permit the fruit to roll gently toward him.

Where sizing machines are used the peaches can be delivered into shallow bins from which the containers can be packed. (Fig. 17.)

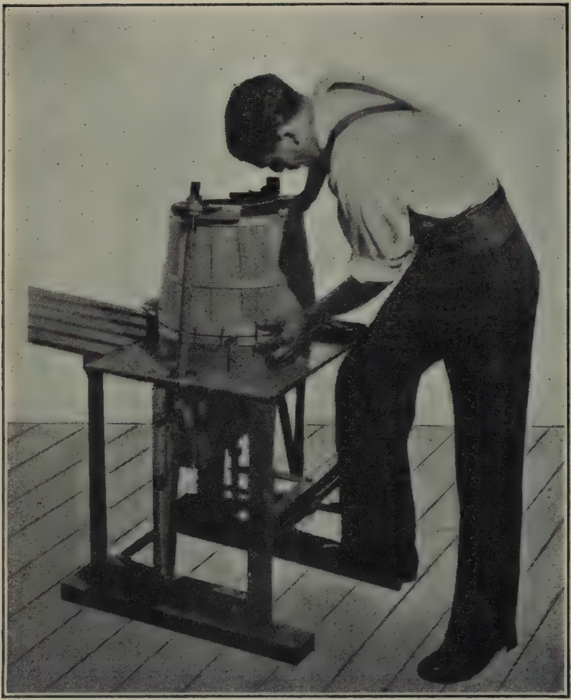

FIGURE 12.—Under this method of packing baskets a press is used to bring the basket tightly down over the contents while the cover is attached

Hand trucks for moving the packed fruit into the car are part of the equipment in modern packing houses.

Chain conveyors are used for carrying the packed crates to the nailing bench in many houses where crates are packed. Such a conveyor can be run with the same power unit that operates the sizer and generally is a desirable part of the packing-house equipment. The conveyor should be equipped with an automatic stop to prevent an accumulation of crates at the nailing benches. (Fig. 18.) With modifications this conveyor can be used in moving packed baskets.

Benches for use in nailing covers on 6-basket carriers are necessary equipment where this type of container is used. The most common form of nailing bench consists of a low, heavily built bench large enough to hold from four to six crates and provided with cleats upon which the ends of the crates rest. These cleats raise the crate high enough to allow the bottom to bulge when the top is

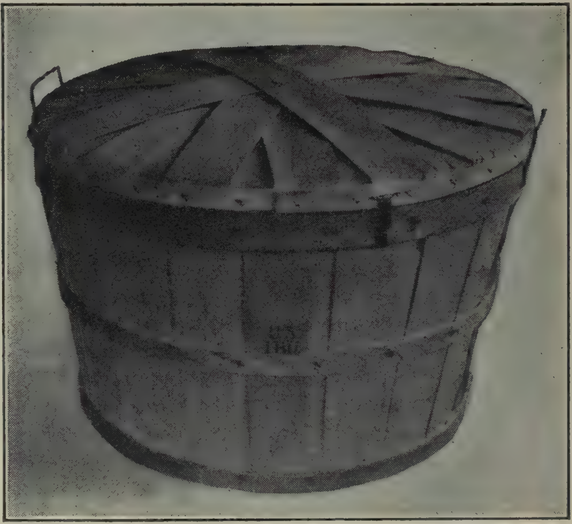

FIGURE 13.—The face of this pack was laid directly in the cover. The basket was brought into place with a press while the flat hooks that hold the cover were put in position

nailed on. If crate conveyors are used the nailing benches are located in the center or at the end of the house; otherwise they are placed at a distance most convenient to the packers.

Crate or basket chutes for moving the empty containers from the loft to the packing floor are aids in efficient operation. (Fig. 19.) The empty containers can be delivered near the packing benches at about the height of the packer's head. The chutes can be kept filled by boys working in the storage loft.

If 6-basket carriers are used, shelves to hold the partitions or dividing trays and baskets should be placed just above the packing bins at about the height of the packer's head.

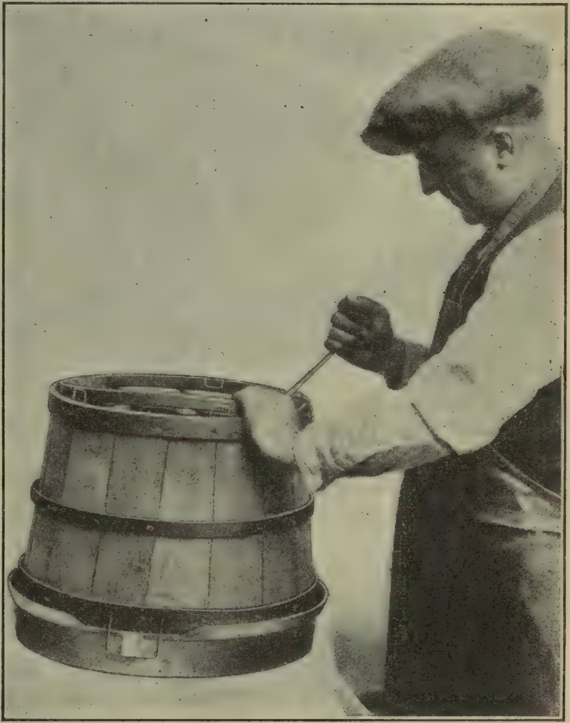

FIGURE 14.—Under this method of packing the removable bottom of the basket is placed in position after the peaches have been packed through the open bottom

OPERATION OF A PACKING HOUSE

Competent and careful supervision is necessary in the successful operation of a peach-packing house. In some of the southern peach districts professional managers frequently are employed; they travel from place to place with the progress of the fruit season.

Formerly, when most of the southeastern crop was shipped in 6-basket carriers, most of the packing was done by professional packers, but during recent years much of it has been done by local help. Local help, when properly trained, frequently is more satisfactory than itinerant labor, being more easily handled and more responsible. Much of the sorting and packing can be done by girls.

MOVEMENT OF THE FRUIT THROUGH THE HOUSE

The arrangement of the equipment in a packing house will depend on local conditions. Usually the driveway for trucks or wagons delivering the fruit from the orchard will be along one side of the house and the railroad tracks or driveway for removing the packed fruit along the other side. The fruit, therefore, usually moves across the width of the house. The arrangement of equipment in a typical Georgia peach-packing house is shown in Figure 20.

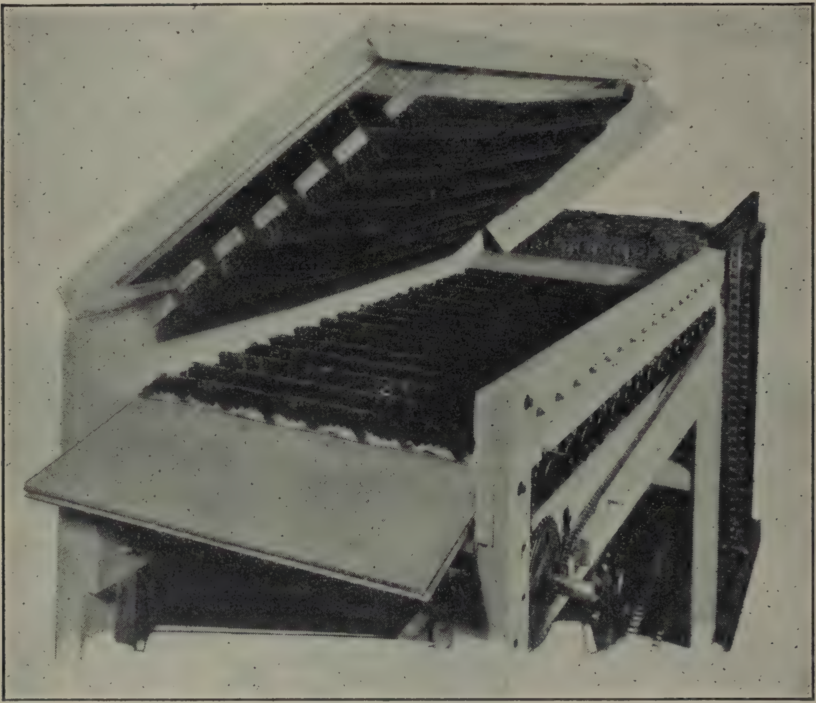

FIGURE 15.—In this type of cleaning or defuzzing machine rotating brushes turn the peaches rapidly against suspended stationary brushes

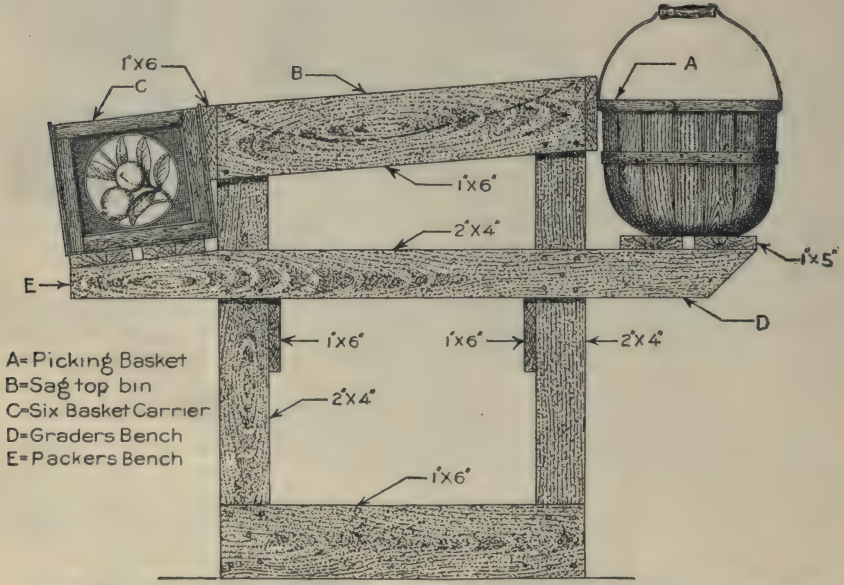

FIGURE 16.—End view of a peach-packing bench: A, Picking basket; B, sag-top bin; C, 6-basket carrier; D, grader's bench; E, packer's bench

It is desirable that the peaches be moved along as rapidly as possible in the packing process because deterioration is rapid. The fruit should not be exposed to the hot sun, and when delivered from the orchard it should be placed as near as possible to the place at which it will enter the grading and sizing machine. If the peaches are hauled from the orchard in baskets and the baskets must be piled more than one tier deep on the floor of the packing shed, the upper tier should rest on the edges of the baskets in the lower tier to prevent bruising.

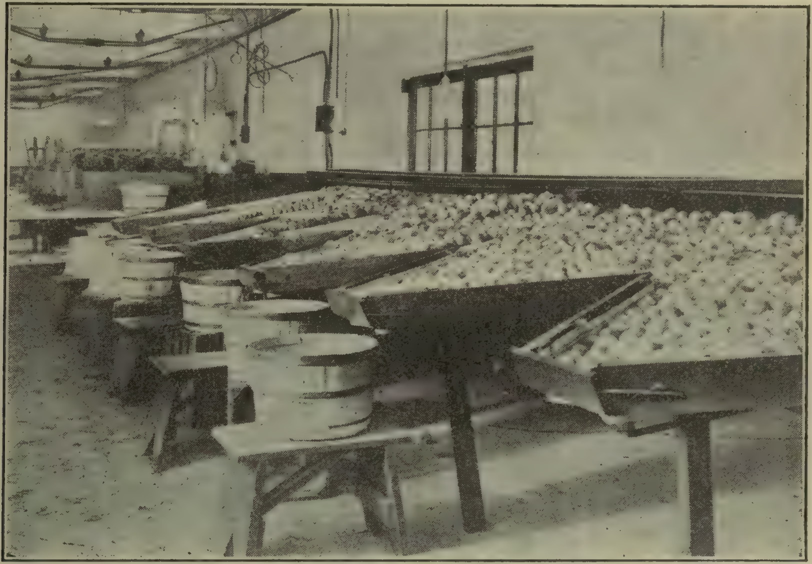

FIGURE 17.—Peaches can be conveniently packed from shallow padded bins to which they are distributed from the sizing machine

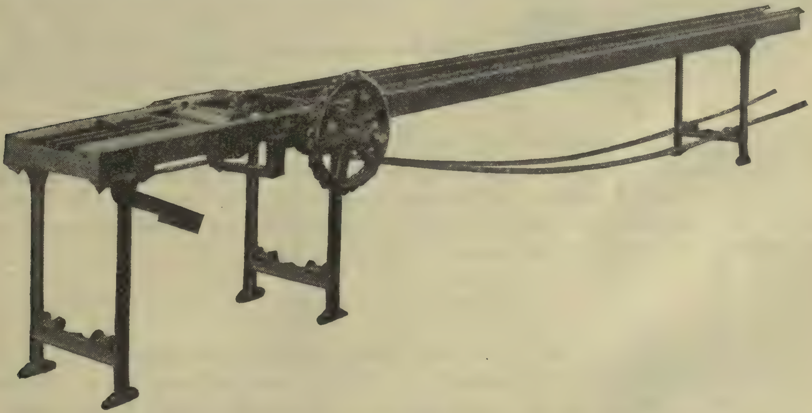

FIGURE 18.—A conveyor used to carry packed crates to the nailing bench. It is equipped with an automatic stop

SORTING

If sizing machines are used, the peaches as they come from the orchard are emptied into the feeding hoppers of the machines.

Tickets placed in the field containers to identify the pickers are collected as the containers are emptied. As the peaches pass over the conveyor before reaching the sizing apparatus the defective peaches are picked out. Both roller and belt types of conveyors are used, but the roller type is more generally used. The rollers are so constructed as to turn the peaches over so that the sorters have an opportunity to see all defects. The number of sorters necessary depends upon the capacity of the machine, the quality and condition of the fruit, and the grades that are being packed. It is extremely important that the sorters thoroughly understand the exact nature of the defects that must be wated for and removed. Constant supervision of the sorting is usually necessary to insure a uniform and satisfactory pack.

Sizing machines are in general use in packing peaches in commercial orchards, but in many producing areas considerable quantities of peaches are sized by hand, particularly at the smaller orchards. Hand sizing is usually done over inclined tables with canvas bottoms. Gravity assists in the movement of the fruit to the lower end of the table where it is packed. The small and defective peaches are picked off as the fruit passes over the table.

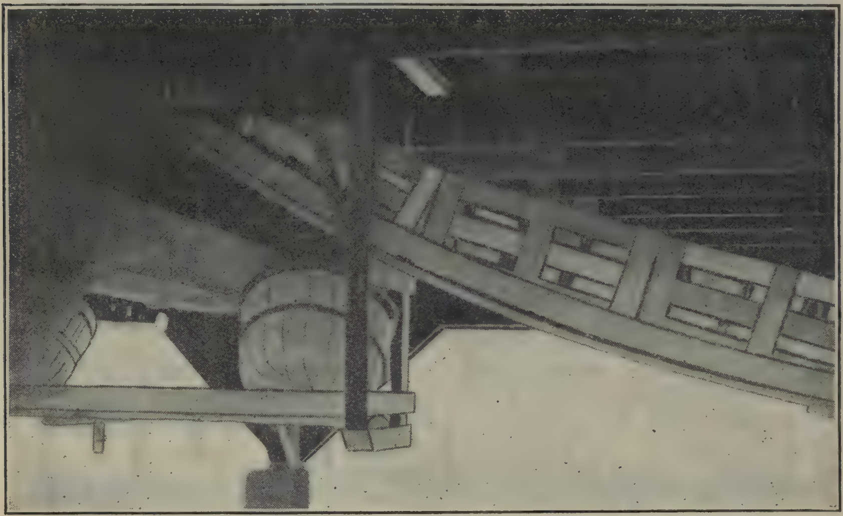

FIGURE 19.—A suitable chute for empty containers which runs parallel to and over the packing benches

PACKING THE BASKET

If sizing machines are used, the sized peaches are generally transferred by mechanical belt conveyors to shallow packing bins. These bins should be padded or constructed to prevent injury from bruising. If mechanical devices for packing bushel or half-bushel baskets are used, the number of facing forms and packing shells necessary depends, of course, on the volume of peaches being packed. Girls are often employed to select the peaches from the bins and ar-

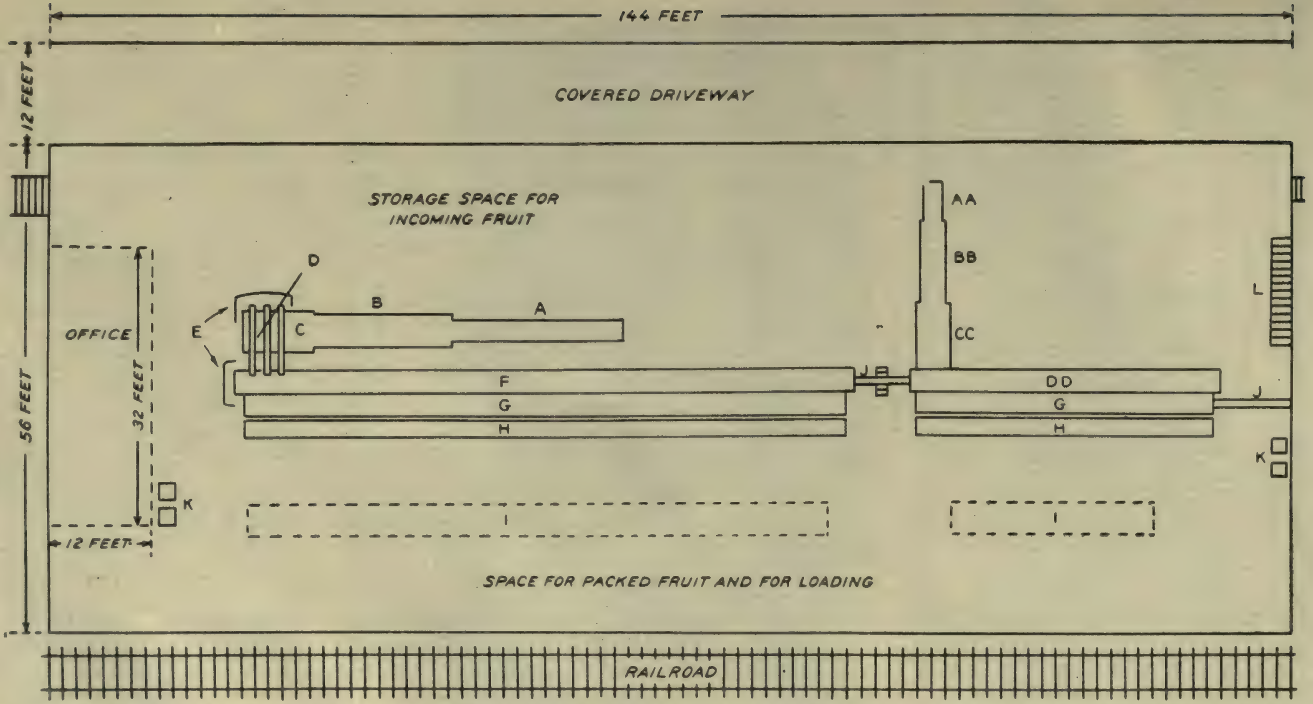

FIGURE 20.—Floor plan of one type of southern peach-packing house with two sizing machines: A, Feed belt (also used as grading belt) 20 feet by 2 feet 6 inches; B, roller elevator, 19 feet by 3 feet 4 inches, for grading; C, sizing machine; D, 3 conveyor belts, 7 feet by 1 foot, from sizer to main belt; E, guard rails; F, conveyor belt, 72 feet by 2 feet 6 inches, to bins; G, packing bins; H, bench to hold crates or packing shells while being filled; I, lidding benches or portable tables for completing basket packs; J, cull belt, 1 foot wide, running under main belt or bins; K, elevator from second floor for containers and covers; L, stairway to second floor; AA, feed belt, 5 feet by 2 feet 6 inches; BB, roller elevator, 10 feet by 3 feet 4 inches, for grading; CC, sizing machine; DD, conveyor belts to bins, 36 feet by 2 feet 6 inches

range them in the facing forms. The fruit must be arranged tightly in the facing form.

If the same facing forms are used in packing peaches of different sizes, in order to obtain a tight face it may be necessary to place the smaller peaches with their longest diameter crosswise of the depressions in the facing form. In packing larger peaches the fruit is laid with the longest diameter lengthwise in the depressions in the facing form. If the face is laid in the basket cover the operation is similar.

The facing forms are placed on benches beside the packing bins while the face is being arranged. The packing shell and liner are then placed on the face and the fruit from the bin allowed to run gently in. A canvas apron attached to the bin helps to prevent bruising. When partly filled the shell should be shaken or racked to settle the peaches and insure a tight pack. The filling is done by men.

The filled shell, with facing form attached, is then carried to a near-by bench where men place the basket over the packing shell and complete the packing. Care should be exercised in turning the basket from the inverted to the upright position. If the filled basket is brought down with too much force there is danger of bruising the fruit.

The pack is usually stamped with the variety and size of the peaches, and the packed baskets are placed in position to be conveniently loaded on a car or truck.

The size of the fruit stamped on the basket is the minimum transverse diameter, taken at right angles to a line running from the stem end to apex of the peach. A common practice in the South is to pack in three sizes, the dimensions of which depend on the variety and the average size of the fruit as it comes from the orchard. In Georgia the general practice is to use size ranges of one-eighth inch for fruit under 2 inches in diameter and ranges of one-fourth inch for fruit over 2 inches in diameter. The minimum sizes in general use are in terms of inches, 1½, 1⅝, 1¾, 1⅞, 2, 2¼, 2½, and 2¾. Elbertas of good size would be classified thus: 2 to 2¼ inches, 2¼ to 2½ inches, and 2½ inches and up. It has been the practice to mark these packs 2-inch minimum, 2¼-inch minimum, and 2½-inch minimum. Stamping the actual size range on the pack would be more accurate.

If baskets are packed through a removable bottom or the face of the pack is laid directly in the cover, the operations are varied accordingly. A few growers put up a solid-ring basket pack in which not only the face but all peaches in the basket are arranged in layers and in concentric rings. Observations have shown that there is little benefit in solid-ring packing so far as the protection of the fruit is concerned, and this method increases the cost considerably.

Only in the smaller orchards are peaches still packed in baskets without the aid of mechanical devices. When the baskets are packed by hand they should be racked or shaken once or twice while they are being filled, to obtain a tight pack. A shaker consisting of a circular, slightly concave device which fits inside the basket is often used in obtaining a proper surface on which to lay the ring face. The top or facing layer of peaches should extend about one-half inch above the top hoop of the basket and about 1 inch higher in the center. In some sections a shallow paper pan is placed in the basket when it is filled up to the facing layer, and the face is then laid in this pan.

PACKING THE 6-BASKET CARRIER

When packing the 6-basket carrier, it is placed on a bench in front of the packing bins. The packer, using both hands, reaches over it for the fruit in the bins, thus working with a minimum amount of effort. Each tier of baskets in the container should be filled one layer at a time. If one basket is completely filled before the others are started the thin veneer sides may be bulged out and the remaining baskets pressed out of shape. When the bottom baskets are finished the dividing tray is put in and the upper baskets are packed in the same manner as the lower tier. It is essential that the peaches in each layer fit tightly in order to reduce to a minimum the amount of settling in transit. To further counteract this settling the crates should be packed high enough to give a good bulge.

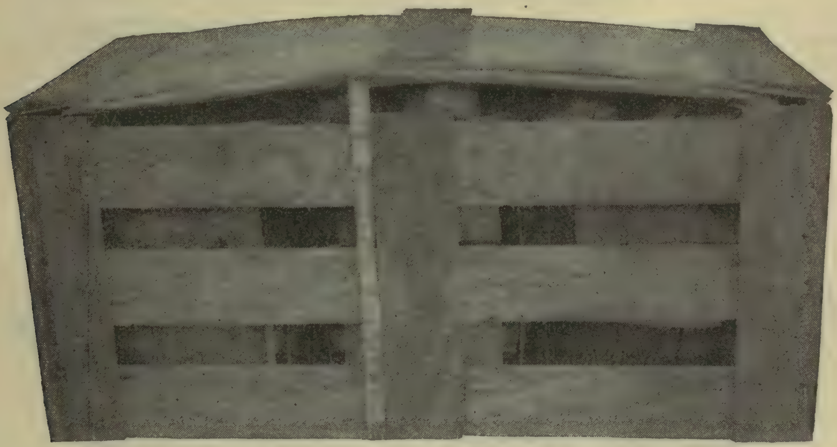

FIGURE 21.—Packed 6-basket carrier of peaches showing a proper bulge

The exact height of the bulge will vary to some extent with the size of the peaches, the larger sizes generally showing a higher bulge than the smaller, but a good tight pack should have a bulge of from 1½ to 2 inches. (Fig. 21.) The most common difficulty is to get the pack high enough, but some growers go to the other extreme and pack the crate with too much bulge, which is likely to cause excessive bruising. A slack pack is likely to give trouble, as the fruit is generally so shaken up in the car while in transit that the order of arrangement, which is one of the principal advantages of this type of package, is disturbed. The pack should be slightly lower at the ends than in the center, and the surface should be smooth, so that the cover will touch each peach with equal pressure. The diagonal system is used in all the standard packs, permitting less

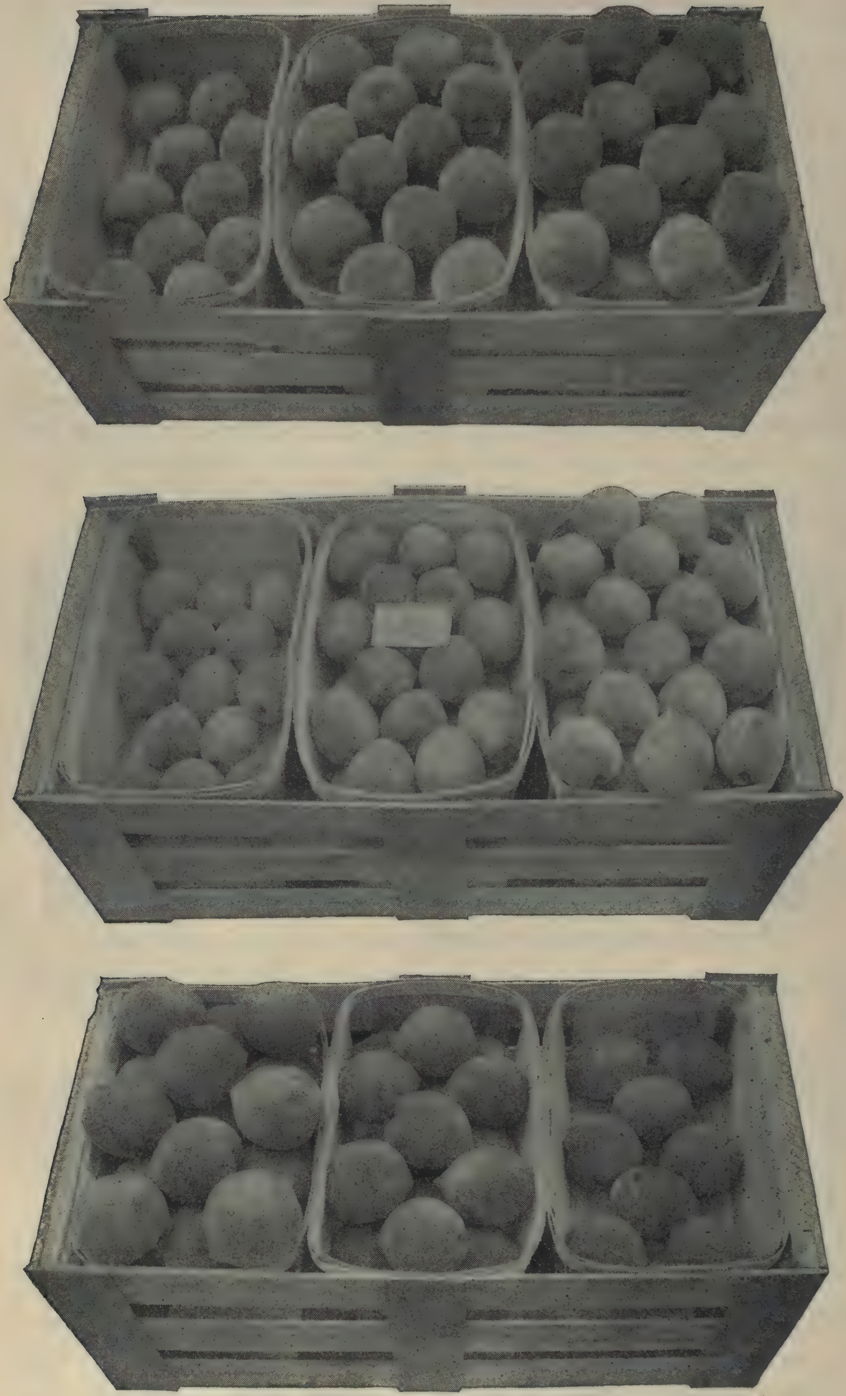

FIGURE 22.—Above, 2–2 pack; middle, 3–2 pack; below, 2–1 pack

likelihood of bruising the fruit than do straight packs in which the peaches in the upper layer rest directly on those below. (Fig. 22.)

The following packs are in general use for Georgia peaches in 6-basket carriers:

	Peaches
2–1 pack, 6 layers, 108 peaches:	
Bottom layer	6
Middle layer	6
Top layer	6
Total	18
2–1 pack, 6 layers, 138 peaches:	
Bottom layer	8
Middle layer	7
Top layer	8
Total	23
2–1 pack, 6 layers, 162 peaches:	
Bottom layer	9
Middle layer	9
Top layer	9
Total	27
2–2 pack, 6 layer, 180 peaches:	
Bottom layer	10
Middle layer	10
Top layer	10
Total	30

	Peaches
2–2 pack, 6 layers, 204 peaches:	
Bottom layer	10
Middle layer	12
Top layer	12
Total	34
3–2 pack, 6 layers, 258 peaches:	
Bottom layer	13
Middle layer	15
Top layer	15
Total	43
3–3 pack, 6 layers, 306 peaches:	
Bottom layer	15
Middle layer	18
Top layer	18
Total	51

A few very large peaches are also put up in a 2–1 pack with 5 layers. Terms in general use to indicate the size of peaches packed in 6-basket carriers are: 2–1, 5 layers, very large; 2–1, 6 layers, large; 2–2, 6 layers, medium; 3–2, 6 layers, small; 3–3, 6 layers, very small.

After the carrier or crate is packed it is passed to the man who nails on the cover. A protecting pad is usually put over the top layer before the cover is placed on the crate. The crate is then stamped with the variety, grade, and size of peaches. Labels showing the brand, and the name and address of the shipper are usually pasted on the ends of the crates. The men who put the crates together and nail on the covers are usually experts and frequently travel from one producing section to another as the season progresses. Professional packers usually put up 125 to 150 crates a day and some pack as many as 200 crates a day under favorable conditions.

If it is necessary to stack the packed crates more than one layer high on the packing-house floor before loading them on the car or truck, strips of lumber about 2 inches thick should be laid across the ends of the crates for the upper layer to rest on in order to prevent bruising of the peaches under the bulge of the cover. The crates should not be placed on their sides as this may disarrange the peaches in the baskets.

PACKING THE BOX

In the Western States the box (p. 12) is used. In many western orchards the fruit is sorted and sized by hand on inclined tables with canvas or padded bottoms or in square canvas-bottomed bins. In the latter case the small and inferior fruit is sorted out as the peaches are transferred from the field containers to the bins by hand. The packer sizes the peaches as he packs from the bin.

Sizing machinery is used to some extent in the centralized packing houses or large individual houses. The fruit is wrapped in paper as it is packed in the boxes, which are placed on a bench in front of the bin or hand-sorting table. (Fig. 23.) The wrappers, which may be of tissue paper, should be strong enough not to tear easily. The wrapper is usually from 8 to 10 inches square, depending on the size of the peaches, and frequently has a design or brand printed on it. The method of wrapping is similar to that employed in wrapping boxed apples.

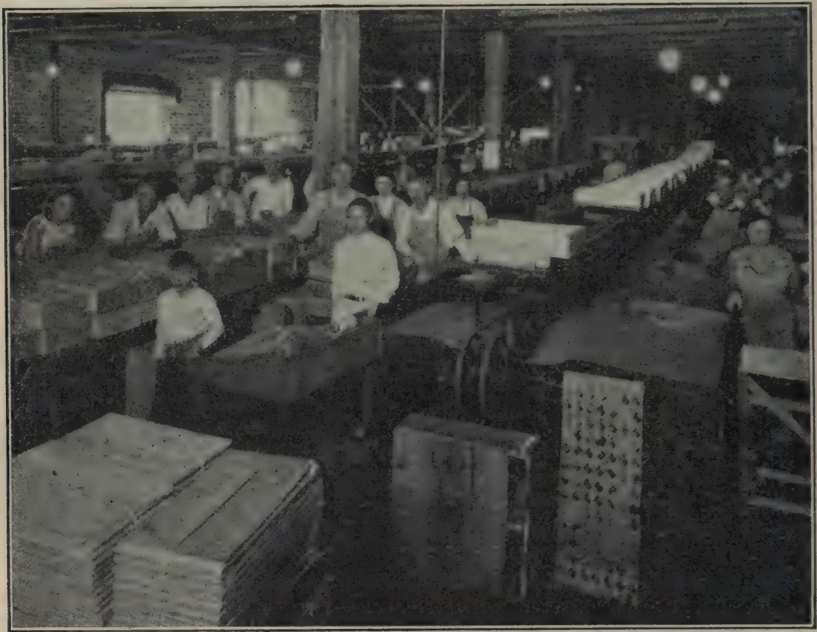

FIGURE 23.—Interior of a large northwestern peach-packing house where the fruit is packed in boxes

The fruit is usually so placed in the box that the peaches in alternate rows are not directly opposite each other but fit as far as possible into the space between the peaches in the next row. The peaches in the second layer are not placed directly over those in the first layer. This is called a diagonal pack because of its appearance. (Fig. 24.)

Table 1 shows the arrangement of peaches of various sizes in the box packs.

TABLE 1.—*Arrangement and number of peaches packed in boxes*

Peaches in adjacent rows		Layers in the box	Peaches in the box	Peaches in adjacent rows		Layers in the box	Peaches in the box
Crosswise of the box	Lengthwise of the box			Crosswise of the box	Lengthwise of the box		
Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
3–3	8–8	2	96	2–3	6–6	2	60
3–3	8–7	2	90	2–3	6–5	2	55
3–3	7–7	2	84	2–3	5–5	2	50
3–3	7–6	2	78	2–3	5–4	2	45
2–3	8–7	2	75	2–3	4–4	2	40
3–3	6–6	2	72	2–2	4–5	2	36
2–3	7–7	2	70	2–3	4–3	2	35
2–3	7–6	2	65	2–2	4–4	2	32

HAULING FROM THE PACKING HOUSE

In hauling peaches to market by motor truck or in hauling from the packing house to the railroad, care to prevent bruising is necessary. If the peaches are packed in bushel or half-bushel baskets, the baskets should be arranged tightly in rows on the truck bed. Each basket in the second tier should rest as much as possible on the rims of two baskets in the first tier, to prevent bruising peaches in the bulged face of the pack. In hauling a considerable distance the load should be so arranged that it will not shift. Pieces of lumber may be used as bracing.

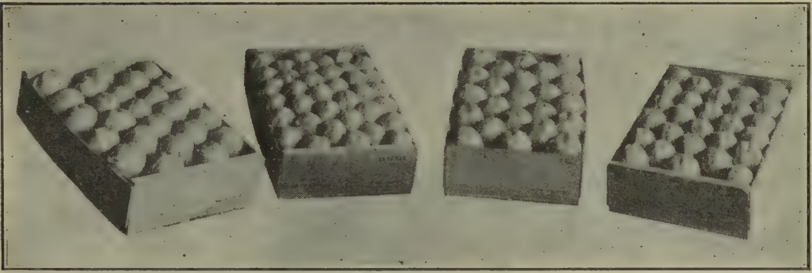

FIGURE 24.—Wrapped peaches packed in western boxes, showing method of arranging peaches of various sizes

Trucks equipped with 2-tier racks are used by some shippers. (Fig. 25.) Boards supported by uprights and crosspieces may be used for the floor of the second tier. The boards must be removable so that the packages in the lower tier may be loaded and unloaded conveniently. A deck consisting of two parts, each the length of the truck bed and one-half its width, and both hinged to a piece of timber running lengthwise of the truck at the middle of the deck, is a convenient arrangement. The wings of this type of deck can be raised to permit loading and unloading the lower tier.

Six-basket carriers should not be loaded on their sides in trucks, as this may disarrange the peaches in the baskets. When crates are loaded more than one layer high without a deck, strips of lumber should be placed across the ends of the crates in the lower layer to prevent the second layer from resting heavily on the bulge of the lower crates.

LOADING THE CAR

Essential points in loading a car are: The packages must be so arranged and braced that the load will not shift in transit and damage the fruit; they must be arranged to permit circulation of air through the load so that proper refrigeration can be obtained; the weight of the upper layers should not rest on the fruit in the lower layers. The car should be iced 12 hours or more before loading and the doors kept closed. The fruit should be protected from the hot sun while waiting to be loaded. Precooling the fruit before loading, if time and facilities permit, will promote lower temperatures in transit.

In a standard method of car loading of bushel baskets a row is started at one end and at the opposite side from the door where the peaches are being brought in. The row is placed the length of the car with the baskets tightly together. (Fig. 26.) If there is vacant space between the last basket in the row and the end of the car, a bulkhead or bracing frame the width of the car and the height of the load should be constructed of boards or pieces of lumber to prevent shifting of the load. It should be so constructed as not to interfere with circulation of air through the load. A tight load that will not shift must be obtained. Shifting of the load in transit often results in loss to the shipper. It is desirable to have the baskets arranged so that the handles are all in the same relative position and so that a line through the handles would be diagonal to the side of the car.

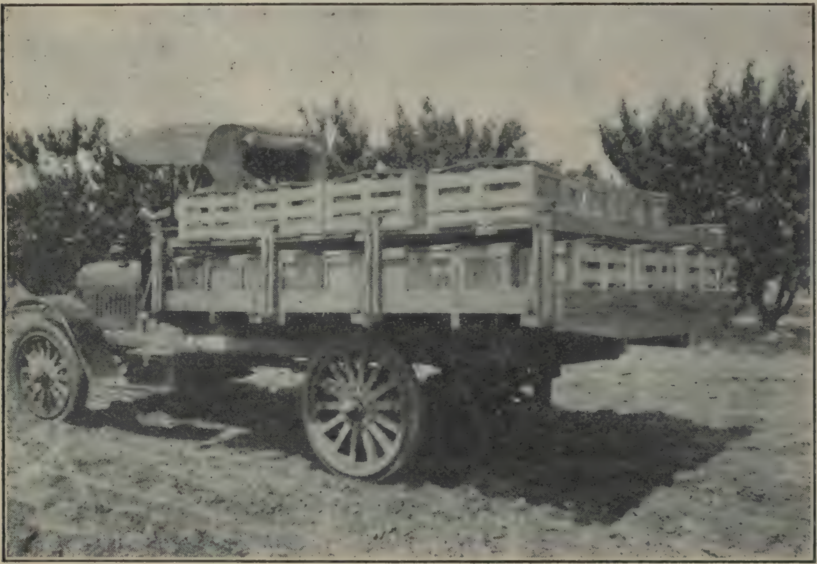

FIGURE 25.—This truck is equipped with a 2-tier rack, so that the containers in the upper tier do not rest on those below

The second layer of the first row is started at the same end of the car as the first layer, the baskets being placed so that they are not centered over the baskets in the first layer but so that each basket rests on the rims of two baskets in the first layer. The baskets in the third layer of the first row are then placed in positions similar to those of the baskets in the first layer. The second row, three layers high, is then placed in position, starting at the same end of the car. The baskets in the lower layer of the second row should be offset with those in the lower layer of the first row.

After three rows (the length of the car and three layers high) have been placed, the remaining rows should be started from both ends of the car so that more room is allowed for bringing in the baskets. The load, the full width of the car and three layers high, is thus finished at the doorway.

Sometimes, if platform trucks are used to haul the baskets into the car, the load is built up to the full height, beginning at each end, so that the trucks will have plenty of room.

Occasionally cars have been loaded with part of the baskets inverted. This is not a good practice, as it may cause bruising of the fruit and may interfere with proper circulation of the air through the load.

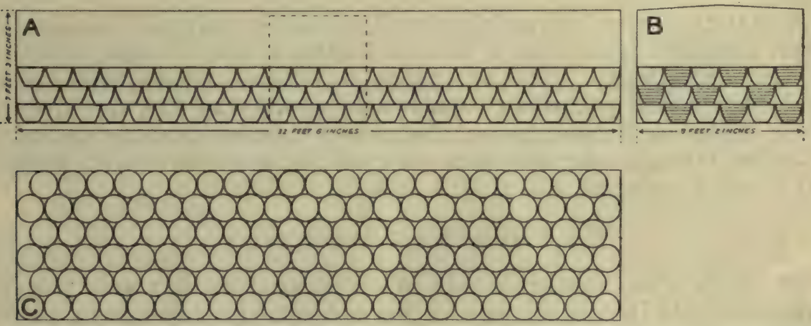

Figure 26.—Plan for carload of peaches in bushel baskets, 3 layers high and 129 baskets in each layer, or a total of 387 baskets in the load: A, Side view; B, end view; C, floor view

The number of bushel baskets loaded per car varies somewhat in different sections owing to variation in the arrangement of packages and in the size of cars. If the top layer is not completely filled out or if extra packages are placed on top of the load, special bracing must be used to prevent shifting of the load. In Idaho and Utah the load is usually four layers deep, making a total of 516 baskets. In Illinois and some other States, 396 bushel baskets is the usual load of peaches. This load consists of six rows with 22 baskets in a row, and three layers in the load.

The method of loading ½-bushel baskets is similar to that of loading bushel baskets, and 784 is the usual number in a carload. The usual arrangement in the car is eight rows wide, offset; 24 and 25 stacks long; and four layers high.

Crates or carriers are loaded seven rows wide and four layers high. When 16 stacks are loaded there are 448 crates in the load. The crates are placed end to end, lengthwise of the car, with their tops up and not on their sides. Spaces are left between the rows from end to end of the car so that air will circulate and give proper refrigeration. Bulkheads or braces are placed at the end of the car if necessary to obtain a tight load. Car strips are used to support the load and prevent the crates from bruising the peaches in the bulge of the crates in the under layers. These strips should be almost as long as the car is wide and thick enough to prevent the weight of the upper layers from resting on the bulge of the crates in the lower layers. They should never be less than 1 inch thick and 1 inch wide. The strips should be nailed across both ends of the crates and one end of each strip should be tight against the side of the car, alternating from one side of the car to the other. The crates in the second and higher layers are placed in exactly the same relative positions as are those in the first layer.

The common load of western boxes of 4½-inch depth for a refrigerator car is 1,260. Following are some descriptions of these loads: (1) Through load, 7 rows, evenly spaced, 20 stacks, 9 layers, fifth and top layers stripped. (2) Divided load, 7 rows, evenly spaced, 9 stacks, 10 layers; 10 stacks, 9 layers; fifth and top layers stripped. (3) Divided load, 7 rows, evenly spaced, 18 stacks, 10 layers; second, fifth, seventh, and top layers stripped. Ordinary building lath is used for stripping.

A standard type of bracing used by many shippers consists of seven uprights against each face of the load, two of these reaching to the car ceiling. Three stringers are placed across each set of uprights; and 12 wedges or cross braces are used to lock the bracing. Some shippers economize on the above type of bracing by using only two stringers against each face of the load, and eight wedges. All bracing material is of 2 by 4 inch dimension.

STORAGE OF PEACHES

At times when market conditions appeared to warrant, peaches have been held in cold storage for limited periods before being placed on the market. Whether this practice is justified depends on market conditions and outlook at the time, the quality of the fruit, and expense of storage. It has seldom been found advisable to hold peaches in storage for more than a few weeks.

GRADES AND INSPECTION

United States grading standards for peaches are in general use. These standards define in detail the requirements of the various grades and specify the tolerances of defective peaches which may be allowed in the various grades. The size of the peaches is stated separately from the grade. Thus, peaches of any size, as 2 to 2¼ inches in diameter, may be United States Fancy, United States No. 1, or United States No. 2 grade. (For specific information on sizing practices see pages 24 to 29.) Copies of the grading standards are available for distribution by the Bureau of Agricultural Economics, United States Department of Agriculture.

The Federal-State inspection service at shipping point is available in most of the important commercial peach-producing areas. For a small fee the Federal-State inspection of a shipment can be had, including a certificate that shows the grade and size of fruit in the shipment and gives other pertinent information, such as kind of containers used and method of loading. Federal inspection is also available in the large markets. There were 16,312 cars of peaches inspected at shipping points in 1931 compared with about 6,600 cars for the small crop of 1932. These figures are 44 per cent and 46 per cent respectively of the annual car-lot movements exclusive of shipments to canneries.

The general use of standard grades by growers and shippers has a number of advantages. It establishes confidence among buyers and sellers and helps to widen the market. Inspection at shipping point under standard grades tends to prevent unjustified rejection at destination in the case of a sale made f. o. b. usual terms. The grades serve as a common language between shipper and distant buyer and constitute a basis of quoting sales which is understood throughout the industry. Their use encourages better production methods among growers, for a premium in price is usually received for the higher grades as compared with lower grades or orchard-run fruit. The presence on the markets of poor quality and ungraded fruit adversely affects the sale of good stock.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1703

RESERVOIRS *for* FARM USE

MOST FARM reservoirs are used to supply water for irrigation, for livestock, and domestic use, and as swimming pools and fish ponds. This bulletin describes the construction and maintenance of such reservoirs, to be used for the storage of comparatively small quantities of water.

The builder of a dam must comply with the laws and regulations of his State covering such structures. Wherever a large quantity of water is to be stored or the dam must be high or of an unusual type, the builder should first consult a competent engineer, but where only a small quantity of water is to be stored and the required dam is low, the simple instructions given in this bulletin should enable a farmer to plan and build his own reservoir.

This bulletin supersedes Farmers' Bulletin 828, Farm Reservoirs.

Washington, D.C. Issued June 1933

RESERVOIRS FOR FARM USE

By M. R. Lewis, *Agricultural Engineer, Division of Irrigation, Bureau of Agricultural Engineering, United States Department of Agriculture, and Irrigation and Drainage Engineer, Oregon Agricultural Experiment Station*

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USES OF FARM RESERVOIRS

FARM RESERVOIRS are most commonly used in connection with pumping plants, since it is often desirable or necessary to use pumps of rather small capacity, especially to pump water from wells. Careful consideration should be given to the type and size of the pump.[1] In areas where it is not possible to obtain wells yielding large quantities of water, it is possible, by continuous pumping, to impound enough water in reservoirs to irrigate a pasture and a garden. Figure 1 shows a reservoir filled by pumping with windmills.

Under some irrigation systems water is delivered on a rotation schedule, and unless a storage reservoir is provided livestock can be watered in the interval between irrigations only by pumping from wells. In many places in the arid States considerable pasture is available if water for livestock can be found. Often it is possible to fill small reservoirs with water from the spring run-off or from intermittent rains, and livestock can then be grazed on the adjoining range and watered from these ponds.

Small ponds often may be used for recreational purposes. Ponds used for storing irrigation water may be used also as swimming pools, and some ponds are stocked with fish. If the water stands in ponds for more than a week at a time, there is always the possibility of mosquito breeding. Certain species of small fish will feed on the mosquito larvae and help very materially in abating this nuisance.

WATER SUPPLY

Water for small farm reservoirs may be obtained from pumped wells or from flowing wells. If a flowing well is located below the land to be irrigated, it may be necessary to pump water to the higher ground. If the discharge from the well is small the reservoir should be located on high ground rather than on low ground adjacent to the well. If the well is on high ground a small pump can be used to fill the reservoir, but if the reservoir is on low ground a large pump is necessary to supply sufficient flow for efficient irrigation.

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[1] Information on pumps and wells is contained in Farmers' Bulletin 1404, Pumping from Wells for Irrigation.

Likewise the water from a spring on high ground may sometimes be impounded in a reservoir below the spring and above the land to be irrigated. If the spring is on the lower ground it will be best to locate the reservoir on high ground and install a pump at the spring to fill it.

Occasionally the discharge of a spring is small and spread out over such an area that the only sign of water is a swampy patch of ground with a growth of rank vegetation. Such a so-called "seep spot" may be excavated and the water allowed to accumulate in the excavation until sufficient volume has accumulated to provide a good irrigation stream.

It is sometimes feasible to store the spring run-off from small areas on individual farms. Where the rainfall comes in torrential downpours, it may be possible to store the surface run-off. In regions of light rainfall water from comparatively large areas may sometimes be collected in small reservoirs and used for irrigation.

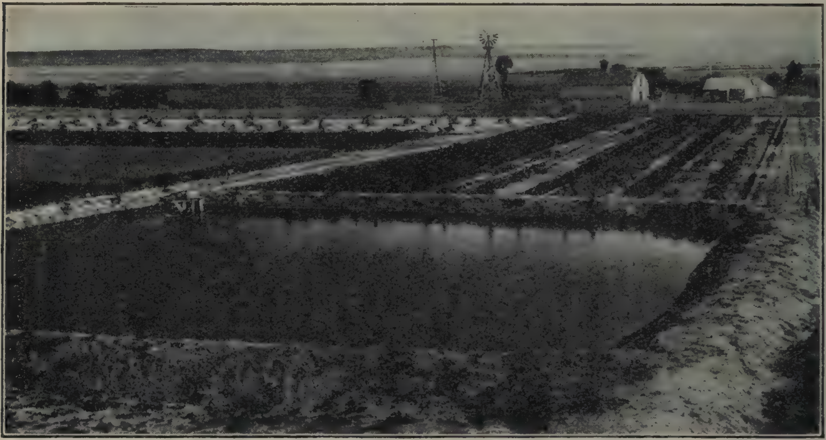


FIGURE 1.—Earthern reservoir filled by pumping with windmills, Cheyenne, Wyo.

In some areas small perennial streams may be used to fill farm reservoirs. In the more humid sections the discharge of small streams which normally do not carry enough water for satisfactory irrigation may be stored and used for irrigation or other purposes.

Some irrigation canals are operated on a "continuous-flow" basis. Under this system an individual farm may be entitled to a stream of water too small for certain types of irrigation. If the continuous stream can be stored in a reservoir for a few days, better results may be obtained. In other cases gravity canals may deliver water during periods of flood run-off faster than it can be used economically for irrigation, and the excess may be stored in small reservoirs and used later.

CHOOSING THE SITE

Often a reservoir may be constructed by building a dam across the channel of a stream which seldom carries water. Occasionally it is possible to find depressions through which no streams flow but which are suitable sites for small reservoirs. If there is no natural depression it will be necessary to build up an embankment and thus create a pond. Such construction is more expensive than where a natural site can be had. However, it often is economically feasible to build reservoirs on either sloping or level ground.

The site on which the reservoir is to be built will greatly influence the character of construction. In deciding on a proposed site, the first consideration is to determine tentatively the location and dimensions of the required dam. If its height and length are not too great to be practical the next problem is to determine whether the proposed reservoir will hold water. Generally the tract will be suitable for a small storage reservoir, if it already is holding some water or is traversed by the channel of a stream which does not lose water rapidly by deep percolation. In areas where the underlying rock is either limestone or lava, or where there are large deposits of gypsum, special care should be taken to determine the water-holding character of the site. Depressions in such areas often are caused by the collapse of caverns formed by the dissolving of limestone or gypsum, and an attempt to store water in such a place is likely to fail.

Sometimes a satisfactory reservoir can be built even over porous or cavernous rock if the soil cover is very thick. When the construction can be carried on in stages, storage of water at each stage may demonstrate the ability of the formation to hold water, but even then there will be danger that as larger volumes of water are stored the increased pressure may cause a break into some underground channel and the undertaking may fail.

If the site of the reservoir is reasonably watertight, the next step is to investigate the foundation for the dam or levee. To determine the nature of the subsoil, pits should be dug several feet deep unless solid rock is encountered. In addition to the pits, a number of borings may be made with post-hole or soil augers. The construction of the dam will depend very largely on the conditions shown by these examinations.

Perhaps the most satisfactory type of site is a small rocky canyon across which a tight dam can be built with its upstream face sealed into solid rock throughout its length. In such locations, dams made of watertight material, generally concrete but occasionally either metal or wood, will be most satisfactory. Where the dam is to be of earth, a tight clay subsoil is a satisfactory foundation. If the subsoil is composed of sand or gravel, it will be necessary to take this condition into consideration.

LEGAL REQUIREMENTS

In most Western States it is necessary to procure a right to store water. The only exceptions are where water is pumped from underground or obtained from a spring that does not flow off the owner's land. In some States a permit must be secured before wells are drilled or sunk. In the humid sections of the United States no application for the right to store water need be made, but the natural flow of surface streams must not be changed to the injury of owners of riparian tracts farther downstream.

Many States have regulations governing the construction of dams for the storage of water. Generally, in the Western States, supervision of the building of dams is entrusted to the State engineer. In States where water-right applications are not necessary the local district attorney will generally know whether permission to construct a storage reservoir is required. In a number of States where supervision is vested in the State engineer, he must approve plans for any dam more than 10 feet high or intended to store more than a few acre-feet of water.

EARTH DAMS

The material to be used in an earth embankment demands careful consideration. Since the cost of moving dirt increases with the haul, material close to the dam site should be used. The best material is a sandy or gravelly clay. Clay alone is not satisfactory. If the dam is to be built by hydraulic fill (p. 5) clay cannot be used alone because it does not give up the water readily and the material remains more or less fluid and cannot be built up. If the material forming the central mass of a hydraulic-fill dam consists of clay it is impossible to draw off the water. The fluid mass may then break through the coarser material forming the sides, destroying the structure.

Even where the material is placed by machinery, clay without sand or gravel is not satisfactory as it shrinks and cracks on drying and swells when wetted. On the other hand, sands and even sandy loams are not entirely satisfactory because they are not sufficiently watertight. Sometimes both clay soil and sandy soil are available. When both are used they should be mixed thoroughly. This may be done by spreading a layer of one type of soil 2 or 3 inches thick, and over this a similar layer of the other type, and thoroughly mixing the two with harrows or disks. If layers are left unmixed, water will seep through the sandy layers and cause trouble. A satisfactory dam can be made of almost any type of earth if the embankment is thick enough and is built up carefully.

Three factors determine the height of the dam: (1) The reservoir must hold the required quantity of water when the water surface is at the level of the bottom of the spillway; (2) the water level in the reservoir during flood periods must be high enough to produce the necessary flow in the spillway (this problem is discussed under Spillways); (3) the dam must be enough higher than the extreme high-water level to be safe against overtopping by waves. If the reservoir is very small or well protected the danger from wave action may be negligible. In most farm reservoirs a freeboard of 3 to 5 feet above high-water level should be sufficient. On large reservoirs, especially where strong winds blow, the freeboard should be increased, possibly to 15 feet or more.

No matter how carefully an earth dam is built it will settle during the first few years after it is constructed. To provide for settling, the embankment should be 10 percent higher than will be required after complete settling has taken place.

The width of the earth embankment will depend on its height. A dam not over 15 or 20 feet high should have a top about 6 feet wide; if a roadway is to be provided the width should be 8 or 10 feet. For embankments 6 or 8 feet high a width of 3 feet may be sufficient. The slope on the upper or water side should be about 3 horizontal to 1 vertical and on the downstream side about 2 horizontal to 1 vertical. If these slopes are used, the width at the bottom of the dam will be equal to the width at the top plus five times its height.

Figure 2 shows a cross section through the outlet pipe of a typical earth-fill dam.

An earth dam may be constructed by either mechanical or hydraulic methods. Where conditions are suitable and proper material is available, the hydraulic method is very satisfactory, but conditions are seldom favorable for its use.

Where the earth embankment is to be built with machinery the best plan is to spread the earth in layers not over 6 inches thick and roll or otherwise compact each layer thoroughly. The material should be somewhat moist when it is placed. Sometimes, if it is too dry, a stream of water may be run into the borrow pit at night putting the material into good condition to be placed the next morning. Each layer should be spread the full width of the embankment and the central portion kept a little lower than the edges. The embankment should not be constructed in sections nor the earth dumped in the center and allowed to make its own slope. Ordinarily, after each layer has been placed and compacted, the surface should be left rough so that the next layer will bond well with it. A good roller for this operation may be made of a piece of corrugated-iron culvert filled with concrete, with a piece of pipe through the center as an axle. Another satisfactory roller can be made by placing an axle through several cast-iron car wheels. The roller should be drawn back and forth along the dam (crosswise of the stream channel) and the corrugations left will insure a better bond with the next layer than if a smooth-faced roller is used. Sometimes a wheel tractor may serve as a roller. When horses or mules are used on the work their tramping assists materially in compacting the earth.

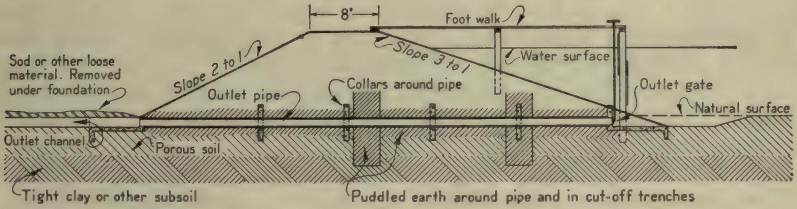

8'
Foot walk
Sod or other loose material. Removed under foundation
Slope 2 to 1
Slope 3 to 1
Water surface
Outlet pipe
Collars around pipe
Outlet gate
Natural surface
Outlet channel
Porous soil
Tight clay or other subsoil
Puddled earth around pipe and in cut-off trenches

FIGURE 2.—Cross section of earth embankment.

If the dam is to be built by the hydraulic-fill method, one or both of two plans can be used. Under one plan the edges of the embankment are built up with scrapers pulled by teams or tractors and the water-borne material is washed into the center of the dam between the two banks thus constructed. The excess water must be carried off by a pipe or a flume over one of the embankments. Under the other plan water carries all the material into the dam. Flumes are built along both edges of the embankment. The extreme outer edge is then protected by wooden planks built up like stair steps. As the water carrying the earth leaves the flumes it spreads out and its velocity is reduced. The result is that the coarser material is dropped near the edge of the embankment and the finer material is carried toward the center. The excess water is carried off by means of either pipe or a wasteway. Care should be taken that the pool of water in the center does not get too deep and that the material which settles out is made up of a mixture of fine and somewhat coarser material.

Under the hydraulic sluicing method, the most convenient and cheapest way of loosening the dirt from the hillsides above the dam is by means of the hydraulic giant, a large nozzle somewhat like that used with a fire hose, through which water is forced under high pressure. The loosened material is then washed onto the dam by the water from the hydraulic giant, supplemented, usually, by additional water brought to the site for that purpose. The hydraulic method can be used economically only where water can either be brought to the dam site through a pipe line from a much higher intake or can be pumped through the hydraulic giant. In either case a considerable supply of water under high pressure is necessary. Occasionally the water, after dropping its load of earth on the dam, is collected in the reservoir above the dam and pumped through the giant again and again. The hydraulic method is feasible only when satisfactory material is located near the end of the dam and on higher ground, so that the water and earth may flow by gravity to the dam.

Under either method the first step is to properly prepare the foundation. The surface soil and any loose vegetable matter on the surface must be removed from the site of the dam. The space to be covered by the base of the dam should then be thoroughly plowed in order to insure a good bond between the natural earth and the embankment.

If the soil is only a few feet deep and rests on tight rock, it may be best to dig a trench about 2 feet deep into the rock along the center line of the dam before beginning to construct the embankment. This trench may be some 4 feet wide and filled with earth either puddled or tamped so that water cannot seep through the joint between rock and earth, or the trench may be narrow and filled with concrete. This is called a "cut-off wall." It should be built up into the embankment a few feet. A similar procedure should be followed if the surface soil is somewhat sandy or full of vegetable matter and rests on a comparatively tight clay subsoil.

If there is a layer of sand or gravel within a few feet of the surface, a trench should be cut through it if possible and a cut-off wall of puddled earth or concrete carried down into tight material. Where the layer of sand or gravel is so deep that this is not feasible, the best plan is to drive sheet piling of wood or metal along the line of the cut-off wall. To do this, a trench 2 or 3 feet deep should be dug the full length of the embankment and the piling driven continuously in the bottom of this trench. If the sand or gravel layer is under several feet of surface soil, the bottom of the reservoir should be puddled so that little water will seep through the bottom into the sand or gravel layer.

If sufficient good material to make the whole body of the dam reasonably watertight cannot be found, the finer material should be placed in the upper side, next to the water, and the coarser material in the lower side. No vegetable matter, such as old logs or stumps, should be used at any place in the embankment as it will decay and leave holes. If there are only a few large bowlders, they may be placed anywhere in the embankment. If there are many of them, they should be put along the lower edge or used to protect the face of the dam from wave action.

PROTECTION OF EARTH EMBANKMENTS

If the reservoir covers more than an acre or so of ground it will be necessary to protect the embankment against wave action, especially where there is much wind and where the water will be held near the top of the dam for comparatively long periods.

If large stones are available, probably the best plan is to cover the water slope of the dam with hand-placed riprap; that is, large stones placed and fitted by hand into a pavement as tight as possible on the upper slope of the dam. If plenty of coarse gravel and bowlders are available, a fairly good protection can be obtained by depositing a 12- to 18-inch layer of coarse bowlders and gravel over the water slope of the dam. Figure 3 illustrates this type of protection.

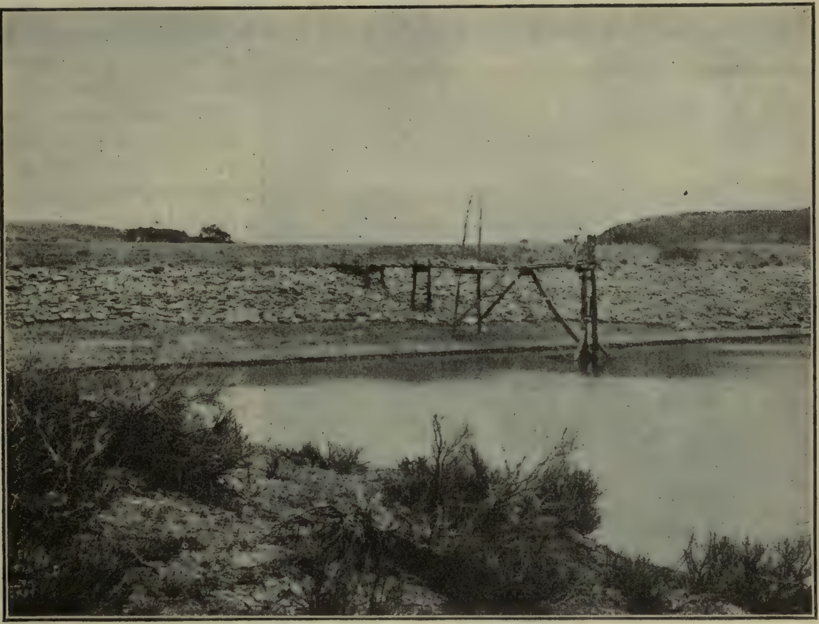


FIGURE 3.—Rock paving on reservoir slope.

If neither stone nor gravel is available, the necessary protection can be provided by a wooden fence along the upper face of the dam close to the high-water level. Such a fence is shown in figure 4. Another plan is to build two woven-wire fences close together a little below the high-water line and fill the space between them with brush or straw held down by stones or logs. Willows can sometimes be planted behind the fence and by the time the fence has rotted the willows will have grown enough to furnish the necessary protection.

Except in the more arid regions the downstream slope of the embankment may be planted to grass which will protect it from erosion by wind and rain. In areas too arid to maintain grass it may be necessary to cover the lower slope, as well as the upper, with a layer of gravel or rock to prevent erosion.

Burrowing animals sometimes endanger small reservoirs, especially those used for irrigation purposes and partly or entirely empty portions of the year. Where such rodents as muskrats, gophers, and ground squirrels cannot be controlled by trapping and poisoning, the embankment may be protected by covering the lower slope, top, and the upper portion of the water slope with well galvanized heavy woven-wire netting of about 1-inch mesh, buried 6 inches or more below the surface to protect it from tramping.

Crayfish sometimes cause trouble by burrowing along outlet or inlet pipes. This may be prevented by placing funnel-shaped pieces of ½- or ¾-inch mesh galvanized screen around the pipe or other structure so that the crayfish will be trapped between the screen and the pipe.

ROCK-FILL DAMS

Loose rock may be used in the main body of a dam in several ways. Sometimes a dam must be constructed on an earth foundation where sufficient suitable earth for building the whole embankment is not available. If loose rock is available, a very satisfactory dam can be made by using it for the lower or downstream part of the dam. The proportion of loose rock to earth will depend very largely on the relative quantities of the materials that are easily available. If a combination dam of this sort is to be built, the best plan is to determine, before construction, approximately how much of each kind of material is to be used. The loose rock is placed first, where it will form the downstream portion of the dam, with side slopes of 1 or 1½ horizontal to 1 vertical. The earth portion of the dam is built on the upper or water side of a rock fill by the same methods and with the same care in preparing the foundation and bonding the earth fill to the foundation as if the whole dam were of earth. The upstream slope of the earth portion of the dam should be about 3 horizontal to 1 vertical, as in the earth-fill dam. Ordinarily one or more cut-off trenches are needed. One of these should be placed near the center of the earth portion of the foundation and the others properly spaced between the center line and the upstream toe.

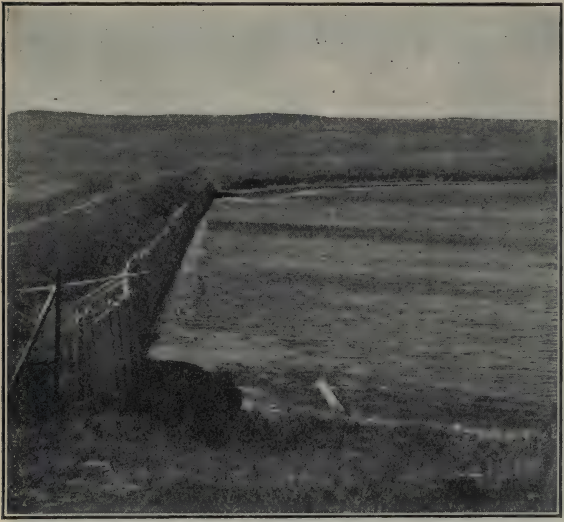


FIGURE 4.—Embankment protected by a board fence.

This type of dam will require the same sort of spillway and the same protection from wave action on the upstream face as does a dam built entirely of earth. The downstream slope, being of loose rock, will need no protection.

Sometimes little or no earth is available, whereas rock is plentiful. Generally when this is true the dam can be founded on solid rock.

All loose material at the upper edge of the site should be removed and a trench cut into the solid rock, if possible. This trench may be filled with concrete forming a cut-off wall and the concrete or wood facing of the dam may be joined to the concrete of the cut-off wall. Figure 5 shows one method of facing a loose-rock dam with timber to make it watertight.

Sometimes a dam of this kind can be covered entirely with wood, and the flood water allowed to pass over its top. Often the central portion of such a dam, directly over the river or stream channel, is made several feet lower than the abutments to serve as a spillway.

Where timber is plentiful, a combination timber and rock-fill dam is sometimes constructed. Logs are used to build cribs, in log-house fashion. These cribs are then filled with loose rocks as large as can be placed. The face of such a dam, like that of a rock-fill dam, should ordinarily be covered with planking. Sometimes the logs in the upper face of a rock-filled crib dam are hewed square so that they fit together and make a relatively watertight face for the dam.

Occasionally a dam of this sort is built on an earth or gravel foundation where it is very difficult to excavate a cut-off trench to solid rock below. In such cases either wood or steel sheet piling may be driven along the upstream toe of the dam and the upper edge of the piling connected directly with the waterproof facing of the dam.

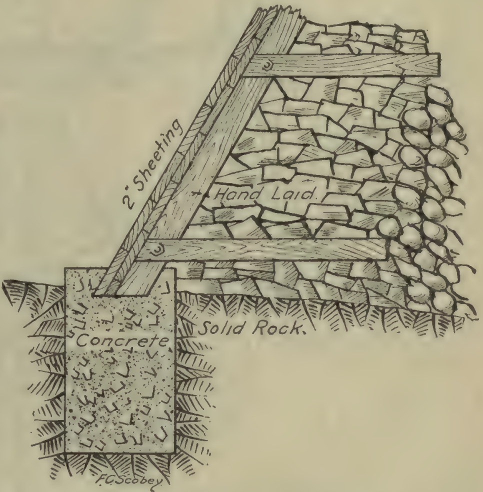


FIGURE 5.—Common method of facing rock-fill dam with timber.

CONCRETE DAMS

Sometimes it is necessary for the flood waters to flow over the top of the dam. In other cases neither large bowlders for a rock-fill dam nor suitable earth for an earth dam is available in satisfactory quantities, but gravel and sand can be obtained. Under such conditions concrete may be the best material.

Three tentative designs for concrete dams are presented herewith which, with modifications, can be adapted to a wide variety of conditions.

One may be used to good advantage in stream beds having bedrock on the bottom and sides, as shown in figure 6. In such favorable locations a concrete dam can be built cheaply with little reinforcing steel, as the greater part of the concrete is in compression. The figure shows one bank of the creek steep so the dam can be built into its rocky face. On the other side of the creek the slope is less steep so a short length of heavy wall or abutment built like a gravity-type masonry dam, is introduced to confine the dam proper to four arches. The number and length of span of these arches will depend on the width of the channel, the height to which the water is to be raised, and other conditions. In the tentative plans shown in figure 6, the water is to be raised 12 feet above the bed of the creek, but the structure is made strong enough to resist a flood flow of 3 feet over the crest of the dam, making a total depth of 15 feet. The bed width of the channel is divided into 4 parts with 3 buttresses as shown. These buttresses are embedded in the rock in order to prevent sliding, and two steel reinforcing rods extend from 3 feet below the bed of the creek up through the entire height of each buttress to prevent overturning and to relieve the concrete of tensile strain. Both the arch sections and the gravity section are embedded in the solid rock where they join the bottom and sides of the channel, to afford greater strength and to prevent leaks.

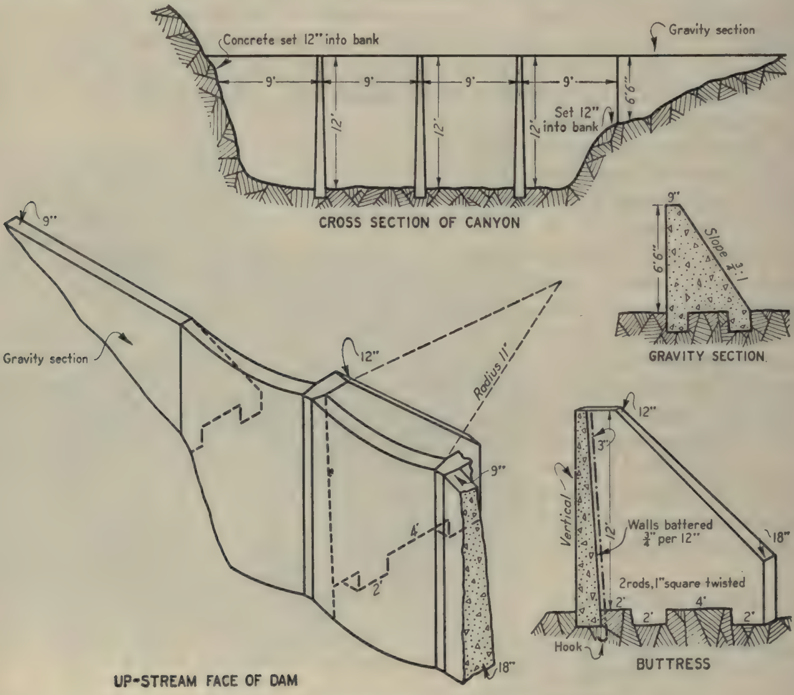


FIGURE 6.—Concrete dam for rocky stream bed.

In the second tentative design, shown in figure 7, bedrock is too far below the surface to serve as an anchorage and watertight connection. The chief problem, apart from the stability and permanence, is to prevent water escaping either under or around the structure. When a small stream finds its way under or past the end of a dam it is likely to erode the finer material and thus enlarge the opening until a large volume of water passes through and the dam is wrecked.

To safeguard the structure against a possible failure of this kind, a cut-off wall of concrete extends not only far below the bed of the creek but also into the banks. The wall forming the dam proper is supported by an abutment on each side and by three buttresses. Such a dam must be safeguarded also against the action of water falling over the crest upon the earth and gravel in the bed of the stream. This protection is provided by extending the floor and sides of the dam downstream and by riprapping the channel—covering the bottom and banks with a layer of stone—beyond the lower end of the structure. The plan shown is designed to hold 12 feet of water in the reservoir and to pass 3 feet over the crest during floods. The concrete is reinforced throughout, and the structure is believed to be amply strong to withstand all ordinary requirements.

It is sometimes necessary to provide a practically unobstructed passage for the stream in order to pass floods during the winter or spring months, closing the stream channel after the heaviest flow is past and conserving water for later use. Figure 8 shows a plan for a concrete structure with wooden flashboards to close the opening. It is designed to permit a maximum depth of 2 feet of water flowing over the flashboards. Such a dam is sometimes useful for diverting water from a stream channel into an irrigation ditch. This design is suitable for a firm earth or gravel foundation. If the foundation material is fine sand or silt, the floor of the dam should extend farther downstream. The channel below the dam will need to be protected by riprap as well as by the wing walls and shallow cut-off wall shown.

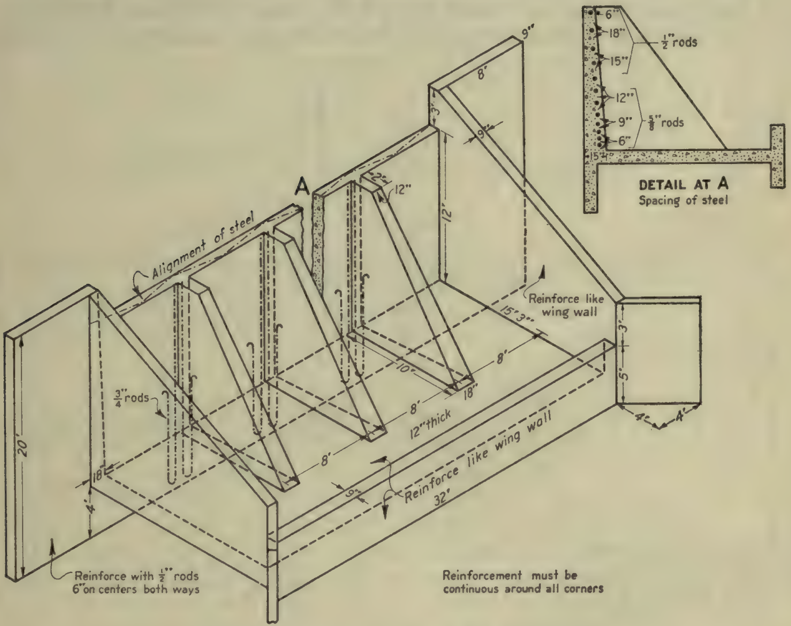


FIGURE 7.—Concrete dam for gravelly stream bed.

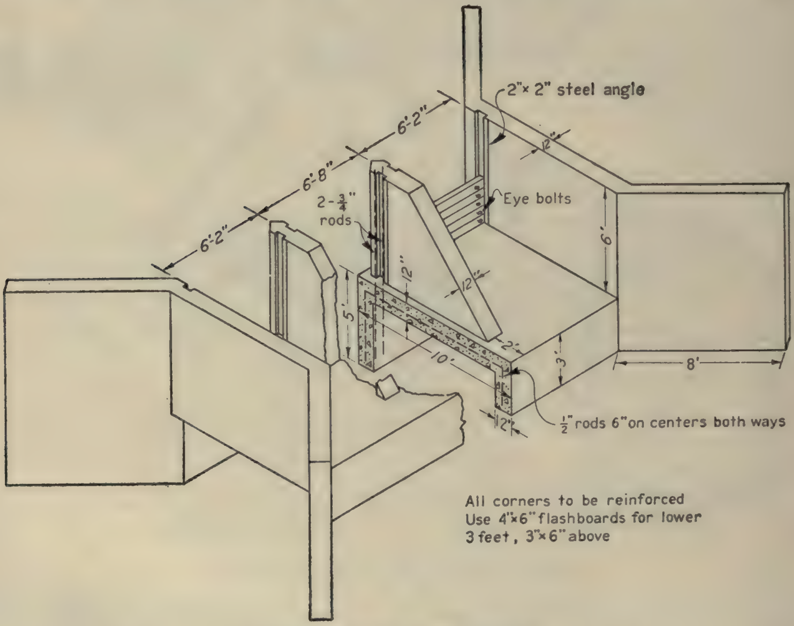
In a canyon with bottom and sides of solid rock, the piers can be used without the floor and abutments. If this is done, the reinforcing rods in the nose of each pier must be firmly anchored into the rock floor by grouting or otherwise. Unless this is done the piers may tip over. In addition, the piers should be set into notches in the rock foundation, as shown in figure 6, to prevent their sliding downstream.

Each flashboard is 6 feet long and has an eyebolt at each end for handling. Two men, one at each end of the boards, will usually be required to place them while water is flowing, but one man can remove them. Short poles with hooks to fit into the eyebolts are used. Foot planks should be fastened to the tops of the piers.

OUTLET AND INLET STRUCTURES

The outlet from a small reservoir will usually be through some sort of pipe. The gate controlling the flow through the pipe should be placed at or near the upper end, otherwise a leak in the pipe would allow water under pressure to escape into the body of the dam and very likely cause its destruction. If the foundation is solid and firm, so that the load imposed by the embankment will not cause it to settle, a concrete pipe of good quality is suitable for an outlet. If the soil is highly charged with alkali or is highly acid, it may be desirable to use vitrified-clay sewer pipe.

If the foundation is likely to settle, some pipe less brittle than concrete or clay should be used. Probably the most permanent pipe is cast iron, but this is expensive, especially if the freight haul is long. For this reason, cheaper pipes are generally used. Creosoted wood-stave pipe or corrugated galvanized-iron pipe may be used. Either should have a life of 15 to 25 years.



All corners to be reinforced
Use 4"×6" flashboards for lower 3 feet, 3"×6" above

FIGURE 8.—Dam with flashboards.

The outlet pipe should be laid, if possible, in a trench dug in the solid ground under the embankment. Cut-off walls or collars should be constructed around it. Ordinarily these walls may be made of concrete, and for the usual small reservoir need not extend more than 1 foot or 18 inches out from the pipe. In most cases 2 or 3 such cut-offs around the outlet pipe will suffice. The earth should be packed carefully around the pipe to prevent water from percolating along it and endangering the dam.

If the outlet gate is put at the upper end of the pipe line, it will be necessary to build out from the embankment to a point directly over the end of the pipe a bridge from which the valve can be manipulated. If the embankment is very low, the gate stem may be laid diagonally up the slope, but usually this is not the best plan.

In all cases some sort of screen or grillage should be provided around the upstream end of the outlet pipe to prevent trash from entering it. If the pond is to be stocked with fish, it will be necessary to use a comparatively fine-meshed screen so that small fish will not be drawn out of the pond. If a fine-mesh screen is necessary it often will be desirable to place a coarser screen a short distance above it. Provision must be made for withdrawing the screens for cleaning when necessary.

If water enters the reservoir by gravity the inlet is usually a ditch, but if the supply is pumped the inlet pipe should be carried through the embankment. If it is carried over the embankment the pumping lift and the cost are increased unnecessarily. If the inlet pipe is placed in or under the embankment, the precautions already described for outlet pipes should be taken to prevent rupture by the weight of the material and to keep water from percolating along the pipe.

SPILLWAYS

The location of the spillway is particularly important. If the dam is in the bed of a stream, the spillway must have sufficient capacity to pass the largest flood that is likely to occur. Perhaps the most practical method of determining the size of a spillway is to examine the stream channel for high-water marks. If these can be found, the cross-sectional area of the stream at extreme high water can be estimated and the size of the spillway based on this. A spillway will carry water off as fast as a stream channel free from obstructions and having the same cross-sectional area, provided it is given as much fall as the stream bed. The spillway should be larger than the stream channel in order to provide for extraordinarily large floods.

If possible the spillway should be located entirely apart from the dam. Sometimes it is possible to use a natural saddle some distance from the dam, and if the spillway can be excavated in solid rock no lining will be required. If the water from the spillway can be returned to the main stream a considerable distance below the dam, so much the better.

If the spillway must be located at one end of the dam, great care should be taken to make sure that water will not undermine the lower toe. The spillway should, if possible, be excavated in solid rock, otherwise it must be lined with concrete or some other material which will not be eroded. The lining should extend far enough downstream to prevent any possibility that the water will cut a channel back into the reservoir.

For very small reservoirs it is sometimes safe to allow the overflow to discharge over a grassy slope that is not too steep.

If the dam is built in a depression apart from the stream channel, or if the reservoir is on a smooth slope or level ground and fed from a canal, a spring, or a pumping plant, the problem is much simpler. Often in such cases no spillway is required, but it is best to provide one large enough to take care of the maximum flow into the reservoir.

RESERVOIR LOSSES

Water losses from reservoirs occur through evaporation from the surface, seepage through the sides and bottom, and leakage through the outlet gate.

In reservoirs lined with concrete or other impervious material, the evaporation losses are the only losses of importance. Evaporation losses for each 24 hours range from nothing, during rainstorms and on cool, damp days when the air is saturated, to a maximum of perhaps one half inch in depth over the water surface during extremely hot and windy periods.

Seepage losses, on the other hand, range from a minimum of one half inch per day to a maximum of 1 foot or even more per day. In most cases a reservoir losing the latter amount would be almost useless. Even where the material of which the dam is constructed is reasonably satisfactory, losses by seepage are often very important. It is therefore desirable to decrease them as much as possible.

As previously stated, the most watertight and satisfactory material for a reservoir is a sandy or gravelly clay, which can be packed so as to be almost watertight. If the reservoir bed is naturally of such materials, all that is needed to make it hold water is to pack it thoroughly. If the water is not to be used for domestic purposes, the best method of packing the bottom is by bedding or feeding sheep on the reservoir site when the earth is wet.

If the bed is not clayey it is sometimes practicable to line it with clay a few inches thick. If a deposit of pure clay is easily accessible, a layer 3 or 4 inches thick can be spread over the bottom and sides of the reservoir and mixed with the surface soil by disking or harrowing. If the whole reservoir bed is then packed by rolling or tramping by stock the lining will be very satisfactory. Here again the use of sheep is recommended.

Where the water supply is drawn from a surface stream which carries fine sediment such as clay or silt, a seal will gradually be formed over the sides and bottom. If a stream carrying a heavy load of coarse sediment is diverted into a reservoir the latter may be filled too rapidly with sediment, It is sometimes possible to draw off the water from near the surface, which carries only the finer sediment, and let the coarser sand and gravel be carried on down the stream.

For a small reservoir, especially when the water is to be used for domestic purposes, some other type of lining may be preferable. Ordinarily concrete will be most satisfactory. If the lining is not reinforced, it should be from 2 to 4 inches thick. The lining should be placed in blocks or squares 15 to 20 feet in each dimension with expansion joints at their edges to prevent formation of cracks that will allow water to leak out. Several types of such joints are shown in figure 9. Complete watertightness can be secured by casting a corrugated strip of copper or lead into the joint. In some cases it is well to use a layer of woven wire to reinforce the lining.

A thin but watertight lining, called gunite, is made by spraying a mixture of sand, cement, and water on woven-wire reinforcing with a special device using compressed air. Provision should be made for expansion and contraction of gunite lining unless it is heavily reinforced with steel. The use of heavy woven-wire reinforcement does not entirely prevent the formation of cracks as the concrete shrinks, but the cracks are so small that they do not permit the loss of water.

The principal danger with a concrete-lined reservoir is that water leaking through the lining will saturate the earth just under the concrete. Then, if the reservoir is empty when freezing weather comes, the water in the soil will freeze and heave, rupturing the lining. If the material in the reservoir bed and banks is porous sandy soil or gravel, there will be little danger from heaving. The rupture of the lining by frost heaving can be prevented by one of three methods: (1) Care can be taken in making the lining watertight, so that no leakage occurs; (2) a thick layer of coarse gravel may be placed just under the lining, permitting the water which leaks through the lining to drain away; (3) in some instances draintile may be laid outside the lining to carry off the water.

PREVENTION OF SILTING

In some sections reservoirs fill up rapidly with silt. There are several methods of preventing this. Sometimes it is possible to build a channel around the reservoir and divert the flood waters, carrying the larger amount of silt after heavy rains, through this channel. After the heaviest load of silt has passed, the clearer water is turned into the reservoir. In other cases, especially if the reservoir is long and comparatively narrow, it is possible to sluice out a good deal of the silt which collects during one or more seasons, by installing large gates at the bottom of the dam and opening them during the high-water period. The water rushing through them will carry out much of the silt.

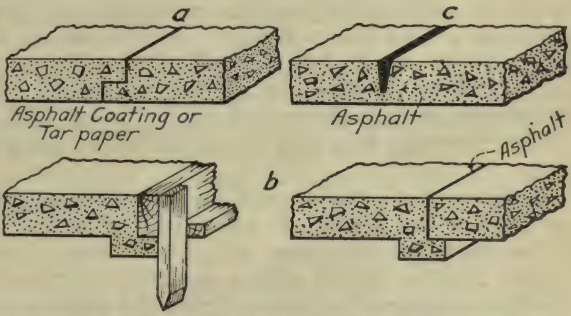


FIGURE 9.—Types of joints used in concrete linings for reservoirs; *a*, ship-lap joint; *b*, reinforced-lap joint; *c*, V-joint filled with asphalt.

Sometimes the filling of a reservoir with sediment can be delayed or prevented by changing conditions on the watershed above. If the watershed which supplies a small reservoir is allowed to grow up to grass or timber, there will be much less erosion and the reservoir will silt up more slowly. In parts of the Western States where the public range has been very heavily overgrazed, erosion is serious and reservoirs silt up very rapidly. Often if an area is protected from livestock for a few years, the grass cover will be renewed and erosion will be decreased.

MAINTENANCE OF RESERVOIRS AND DAMS

Dams and reservoirs must be properly maintained if they are to remain useful. An earth embankment must be kept up to its full height and width. Often, especially on smaller reservoirs, the tramping of stock and the erosion caused by wind and rain wear down the embankment until waves or floods may overtop and destroy it.

The burrowing of gophers and ground squirrels near the top of an irrigation reservoir, or of muskrats and crayfish along the outlet structures below the permanent water line, must be continually guarded against and such burrows closed before serious damage is done. Small leaks caused by this burrowing can not be stopped from the outside. The best plan is to dig a trench on the inner slope, just above the water line until the hole is found. The hole and trench can then be filled with good earth well compacted.

At least once a season, when the water is low in the reservoir, the outlet gate and structure should be carefully examined and repaired if necessary.

The spillway should be examined periodically to make sure that it is not obstructed. If it adjoins an earth embankment or is constructed in earth where its failure would endanger the reservoir, it should be examined for leaks and necessary repairs should be made.

If fish are to be kept in a reservoir the spillway must be screened. If the reservoir is not in the stream channel there will be no particular difficulty in maintaining the screens, but in a reservoir in the bed of a natural stream, the screen may be clogged during high floods, causing the water to overflow the dam and destroy it. A possible solution is to put the screen on posts, as in building a woven-wire fence, at some distance above the spillway. If this screen is built to a moderate height above the bed of the spillway it will prevent the fish from being carried out of the reservoir by small outflows. A big flood will overflow the screen and go on through the spillway, and may carry the fish out of the reservoir but this would be better than the destruction of the dam.

If the water is to be used for domestic purposes the reservoir must be fenced and livestock prevented from contaminating the water. If the water is to be used only for watering livestock, it will be much better to draw it out of the reservoir, through a pipe, into watering troughs below rather than to give the stock access to the reservoir itself because they will trample down the banks and may even destroy them. Moreover, the water will be contaminated and much of it will be lost in the muddy area around the edge, if the livestock have access to the reservoir.

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U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1704

BANG'S DISEASE

(INFECTIOUS ABORTION)

1862 1889

BANG'S DISEASE is widely distributed and results in serious losses to the livestock industry. It is caused by a germ known as *Brucella abortus*. The disease is commonly introduced into healthy herds by the addition of infected cows or infected pregnant heifers.

The act of abortion is its best-known symptom. Other symptoms are weak, though living calves, sterility, and retained afterbirths.

The germs may be in the uterus or the udder, in the generative organs of bulls, in certain lymph glands and joints, and in the intestines and other organs of newly born calves.

Diseased animals eliminate the germs in the fetus, afterbirth, and uterine discharges for limited periods, and in the milk for prolonged periods.

The malady appears to be commonly acquired through the mouth in feed and drink contaminated with the germs, by licking affected animals to which the germs adhere, contaminated mangers, or other objects. The skin and the membranes which line the eyelids may also provide a means of access for the abortion germ into the animal. Proof that bulls transmit the disease through the act of service is lacking.

There is no scientific basis for believing that abortion losses can be prevented or reduced by the administration of drugs or medicinal compounds.

The way to deal with an infected herd depends on how extensively the disease has spread, whether the animals are valuable from a breeding or producing standpoint, whether there are facilities for having abortion tests made, and whether provision can be made for dividing and maintaining the herd as separate units among which there is little or no communication.

This bulletin is a revision of and supersedes Farmers' Bulletin 790, Contagious Abortion of Cattle, and Farmers' Bulletin 1536, Infectious Abortion of Cattle.

Washington, D.C. **Issued July, 1933**

BANG'S DISEASE (INFECTIOUS ABORTION)

By JOHN M. BUCK, *assistant superintendent, Experiment Station, Bureau of Animal Industry*

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BANG'S DISEASE, infectious abortion, contagious abortion, and abortion disease are different names for a livestock disease, especially prevalent in cattle, that causes heavy losses in the United States and most other countries. It has existed for centuries although for a long time its cause remained obscure. During recent years it has gained additional prominence and has become a matter of growing concern to those engaged in raising or handling cattle. As interest in the production of better stock has increased and as the long-distance shipment of animals has become more common, conditions have not only become more favorable for the spread of the disease but have made the losses which it causes of greater consequence to cattle owners.

NATURE OF THE DISEASE

Bang's disease has puzzled stock owners and has been the subject of much controversy among investigators. There has been a tendency to regard the act of abortion, its most usually observed symptom or manifestation, as the disease itself. Viewed in this manner it has been natural to suppose that the malady may commonly be acquired just before the act of abortion and that recovery has taken place when the generative organs show evidence of having assumed their normal condition. Experimental studies have plainly shown that this conception of the disease is erroneous and have at the same time revealed something of its true nature.

It has been determined that the act of abortion is merely one symptom or manifestation of the disease, a rather inconstant one in fact, and that abortion, when it occurs, is commonly induced by a diseased condition of the membranes through which oxygen and nourishment pass from the dam to the fetus. The diseased condition is brought about by the action of germs which may have invaded the uterus of the dam weeks or even months previously. If the gestation period is well advanced before the membranes become severely affected the calf may be weak but living when expelled. When the infection becomes severe during the earlier months of gestation, the fetus is usually dead on expulsion (fig. 1). Whether the dam expels a dead fetus or a calf with sufficient vigor to survive is determined to a great degree by her ability to resist the action of these germs.

Although the act of abortion is the most readily observed symptom of the disease, it has been noted also that in affected herds (1) sterility, or barrenness, is commonly more or less troublesome; (2) animals give birth to calves which, although living, may be too weak to resist some of the more common ailments; (3) cows show a tendency to retain their afterbirths, and (4) a reduced milk production is occasioned by the failure of animals to complete their normal gestation periods. Losses due to these conditions may equal or even exceed those represented by the number of calves that are born dead.

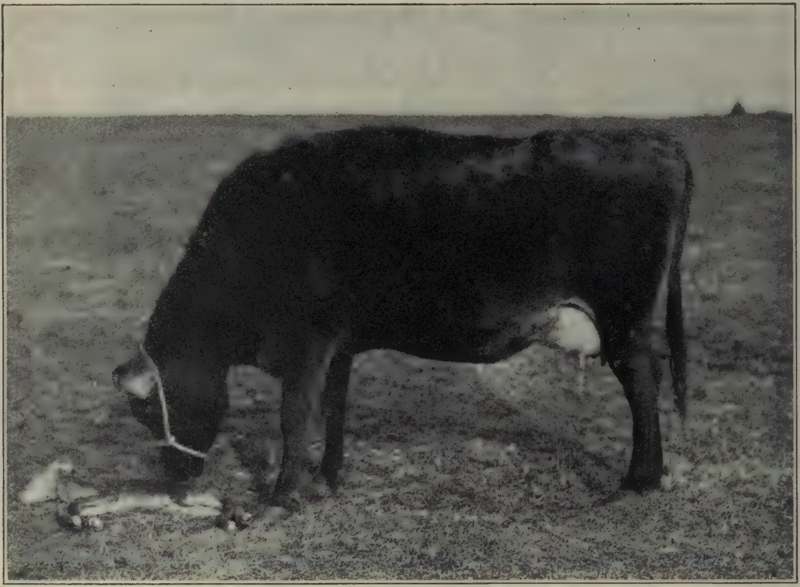

FIGURE 1.—A cow with her dead fetus. This abortion occurred during the seventh month of pregnancy. Cattle of all breeds and degrees of breeding may be affected.

CAUSATIVE AGENT

European investigators recognized the transmissibility of the disease more than 50 years ago, but they were unable to ascertain the nature of the infection that was responsible. It continued to remain much of a mystery, so far as its causative factor was concerned, until Professor Bang, a Danish investigator, announced, in 1897, his success in cultivating from the carcasses of aborted calves a certain germ, which if introduced into the blood stream of healthy pregnant cows caused them to abort. This micro-organism he called *Bacillus abortus*. English investigators a few years later confirmed the work of Bang. During 1900 it was definitely shown that the same type of infection could be isolated from aborted calves in the United States. The discovery of the abortion bacillus marks an important event in the history of the disease, and much credit is due its discoverer, since the cultivation of the germ necessitated the application of methods that were both unique and original.

Twenty-one years after Bang's discovery, Alice C. Evans, an employee of the United States Department of Agriculture, observed that the germ isolated and described by Bang bore an unusually close resemblance to a micro-organism termed "*Micrococcus melitensis*," discovered in 1887 by David Bruce, a surgeon in the British Army, when investigating a human disease in the Island of Malta. Although originally isolated by Bruce from human beings who had succumbed to the disease known as Malta, Mediterranean, or undulant fever, it was later discovered that the infection invaded goats and that the disease was commonly acquired by human beings through drinking the milk of affected goats.

Since the germs discovered by Bruce and Bang, respectively, were found to have many characteristics in common, it seemed desirable to consider them, as well as the abortion germ which affects swine, as belonging to the same genus. The term "Brucella" in honor of Bruce, the discoverer of the first type of the germs, thereupon came into use as the generic name. The different types thus became known as *Brucella abortus* (bovine), which commonly affects cattle; *Brucella abortus* (porcine), the type common to swine; and *Brucella melitensis*, the type found in goats and isolated by Bruce from human beings.

Before the discovery of *Brucella abortus* there were numerous theories as to the cause of abortions. Mechanical injuries, the consumption of moldy or smutty feed, and exposure to odors emanating from aborted calves were thought to cause it. Although such theories have been largely abandoned, investigators have determined that it is not always possible to demonstrate the presence of the *Br. abortus* in all calves that are expelled dead or immature, or in their membranes. Numerous types of germs other than *Br. abortus* have been cultivated artificially from aborted calves. Their significance as causative agents is, however, not completely understood, for while they have been repeatedly found in the organs and parts of aborted calves, their injection into healthy, pregnant cows seems rarely to cause abortion.

During recent years investigators of diseases have been engaged to a considerable extent in studying the effects of certain feeds or the withholding of certain feeds on the health of animals and the proper functioning of the different organs. The results of these studies have suggested that improper feeding may have some connection with abortion losses.

LOCATION OF BRUCELLA ABORTUS IN INFECTED ANIMALS

The act of abortion furnishes little information as to when the disease was contracted or when it will be overcome by an animal. The tendency on the part of the germs to multiply in the bodies of animals for long periods justifies the recognition of the disease as a chronic malady. Information as to the location of the causative germs and the ways in which they are eliminated is important in the eradication of the disease. With an understanding of these factors one is in a favorable position to guard against the transference of the infection from diseased to healthy stock.

The fetus, fetal membranes (afterbirth), and discharges from the generative organs at time of aborting and for a variable period afterwards are usually saturated with the germs. Discharges shortly before the act may also contain the infection. These circumstances contribute greatly toward rendering the control of the disease most difficult. Probably in no other infectious disease of cattle does the affected animal eliminate so excessive a quantity of infected material during a brief period as does the aborting cow.

The aborting animal, moreover, is not alone responsible for scattering the infection. Infected cows, although they produce seemingly normal calves, may be as menacing to healthy stock as if they had aborted, because their afterbirths and uterine discharges may contain myriads of the abortion germs, a feature that until recent years escaped observation.

Only in rare instances have the germs been found in the genital tracts of cows for any great length of time after the dead or living calf has been expelled. Experimental tests indicate that they are seldom present in the discharges longer than 3 or 4 weeks although in rare instances they have been found nearly 2 months after the expulsion of the calf or fetus.

The udders of many infected cows, whether they abort or not, contain and eliminate the germs for a widely variable period. Investigators have never been able to understand or account for the wide variation that exists in the length of time that udder infection persists in different animals. Experimental work has indicated that the abortion germs may be present in the milk of some infected cows during all the rest of their lives after the malady is contracted. Other animals, however, recover from udder infection during the course of a few months or even weeks.

Since it has not been possible to prove that the germs commonly live in cows for any great length of time except in the udders and adjacent lymph glands, the disappearance of the germs from these organs probably signifies in most cases that they are no longer present in the animals. Furthermore, experiments have indicated that those animals which have ceased to eliminate the germs from their udders possess a marked degree of resistance to the affection. On the other hand, as long as udder infection persists, it appears to act as a source of infection for the pregnant uterus, although invasion of the latter organ may not uniformly occur. Unlike numerous varieties of germs, *Brucella abortus*, when present, does not appear to produce visible evidence of udder disease. The multiplication of the germs in this organ seems to be principally a provision of nature for the perpetuation of the infection.

In some instances the infection establishes itself in the generative organs of bulls and causes permanent injury to them, and it has also been proved that the seminal fluid of infected bulls may contain abortion germs (fig. 2). These facts are of considerable practical importance, not only because they reveal the limited value of sheath douchings as a means of rendering the bulls' generative organs free from the causative germs, but also because they explain why bulls should be so handled as to prevent their discharges from contaminating premises accessible to stock free from abortion disease.

Newborn calves from cows infected with *Brucella abortus* may harbor the infection in their intestines and other organs for a brief period and therefore during this time are possible sources of infection to stock free of the disease. Experimental tests, however, have failed to indicate that the infection is eliminated by such calves for an extended period; consequently, minor importance is attached to the spread of the disease by them.

In rare instances the abortion germs have been detected, in cattle, in certain lymph glands other than those adjacent to the udder, and in the joints and the blood.

FIGURE 2.—A bull which proved to be infected with abortion germs, thereby destroying his value as a sire. The disease is rarely evident from the animal's physical appearance.

HOW AND WHEN THE DISEASE IS ACQUIRED

How animals commonly acquire the disease is a question that has engaged the attention of investigators since the discovery of its cause.

For a time it was supposed that the germs gained lodgment on the external genitals of cows and were conveyed through the vagina to the uterus, where they set up inflammation. It was believed that the transference of the abortion germs from the affected to the healthy animal resulted from contact with contaminated gutters or from direct contact between the healthy and the diseased animals. Spraying the tails and external genitals of cows with antiseptic solutions was considered advantageous as a control measure.

It has also been generally believed that cows and heifers commonly contract the disease at time of service. Bulls not themselves infected have been considered capable of transferring the germs from affected to healthy cows by the soiling of their generative organs. This theory appeared to be so logical that its accuracy for many years remained unchallenged, but results of more recent experiments have failed to substantiate it.

Calves show marked resistance to the disease although it was at one time thought that they might carry the infection in their bodies from birth to maturity. Studies of this question have supplied, thus far, only meager evidence to support that belief. The age at which young cattle lose their immunity has not been determined.

The readiness with which susceptible, pregnant cows and pregnant heifers may be infected through the digestive tract by feeding them discharges from cows which have recently aborted has strongly indicated that the malady is commonly acquired by way of the mouth. The disease has not only been produced experimentally in pregnant cows and heifers through this channel, but unbred cows have likewise been made carriers of the germs in their udders and milk. Not only has it been possible to infect cows readily in this manner, but it has been accomplished when the quantities of material fed, containing the germs, have been surprisingly small.

More recent experiments have revealed that there are two other ways that had formerly received but limited consideration, by which the disease may be transmitted to susceptible pregnant cows and heifers. Experimentally the disease has been transmitted to susceptible cattle by depositing a small quantity of *Brucella abortus* infection on the mucous membrane surrounding the eyeball and also by its application to the skin whether the latter was slightly abraded or intact. Although the spread of the disease under natural conditions by these ways lacks definite proof, it seems probable that materials contaminated with *Br. abortus* from infected cows occasionally gain access to the eyes of susceptible cattle or come in contact with areas of their skin and thus transmit the disease.

SYMPTOMS

The symptoms or signs that denote the presence of Bang's disease are rather inconstant and indefinite. The act of abortion is probably the most widely known and most readily observed, but it may easily be misinterpreted, since not all cows that abort are affected with the disease. Its prompt recognition in diseased herds is, moreover, rendered difficult because of the fact that many animals which acquire the disease never abort.

When the act of abortion occurs it may be preceded by changes commonly observed in cows approaching normal parturition, such as enlargement of the udder, slight swelling of the external genitals, uneasiness, and straining. Discharges from the genital tract preceding the act may occasionally be observed. The fetus may be expelled during any stage of its development. If the fetus is small, the act of abortion may occur unobserved.

When the dam aborts during the early months of pregnancy the afterbirth, not being firmly attached to the uterus, is usually expelled with the fetus, whereas during the later months of gestation its retention is common. Some fetuses may be born alive but too weak to survive more than a day or two.

Fluid or semifluid materials are eliminated from the genital tracts of aborting animals for a variable period following the act. The length of time that such discharges continue to be expelled depends on both the severity of the disease in the uterus and the manner of treatment employed. The discharges are usually brownish or yellowish brown, but may not differ greatly in appearance from discharges in cases of retained afterbirth not caused by the abortion germ. The afterbirth, when expelled or removed and examined before becoming markedly putrefactive, frequently shows changes that aid the trained observer in recognizing abortion disease.

Areas of the membrane that are normally thin and translucent may present a leathery appearance or be studded with small elevations, and the borders of the cotyledons (tumorlike enlargements, where union between dam and fetus is established), may consist of a cheeselike substance. The irregular surfaces of some of the cotyledons may likewise be occupied by this cheeselike material. The absence of these changes, however, does not necessarily indicate that the abortion germ has not been active.

Sterility (barrenness) is usually a troublesome factor in herds into which the disease has gained entrance. Although cows which have aborted may conceive at the first service, it is often necessary to breed an aborter repeatedly before conception takes place. Heifers as well as the aborting cows in such herds may show irregularities in breeding.

Because sterility frequently causes more or less trouble in herds free of abortion disease as well as in infected herds, it does not constitute definite evidence that the abortion germ is involved. The retention of the afterbirth likewise does not afford definite information as to the presence or absence of the disease, since that was a frequent calving complication in this country before infectious abortion became widely prevalent.

Although none of the symptoms mentioned furnish definite knowledge as to the presence or absence of the malady, they may well be regarded with suspicion and as justifying prompt action. This applies particularly to the act of abortion. Until a definite diagnosis can be reached it is wise to infer that an aborting animal is affected with the disease and to proceed in accordance with that inference.

DIAGNOSIS

Cattle owners have shown unusual interest in the diagnosis of Bang's disease, since it plays such an important part in eradication programs. There has been some skepticism about the reliability of the agglutination test, the one commonly used. Before the discovery that the infection may establish itself in the udders of cows and be eliminated in the milk for long periods of time, there were reasons for doubting the accuracy of the test. The fact that many reacting animals have produced living, vigorous calves has sometimes been erroneously regarded as indicating that the test is unreliable. It is now well known that the results of the agglutination test throw very little light on whether tested animals will abort, but they do give a reasonably accurate idea whether the animals harbor the abortion germs in their bodies. It is true that many animals recover from Bang's disease and cease to be carriers of the abortion germs after once having contracted the disease, and also that the test fails to differentiate sharply between present and past infections. However, it is possible to distinguish with considerable accuracy, between present and past infection, by the intensity of reactions.

Experiments have shown that after pregnant heifers were fed material infected with *Brucella abortus*, reactions in some cases were slow in developing. In some instances a period of between 3 and 4 months was required before a positive diagnosis by the agglutination test was established. It seems reasonable that when animals acquire the disease in the usual manner in infected herds, a like period may sometimes elapse before the fact is revealed by the test. A single test, consequently, cannot always be expected to give the owner of exposed animals definite assurance that they are not in the early stage of the disease.

Even though not perfect, the agglutination test constitutes the most satisfactory means of diagnosis available, from the standpoints of reliability and practicability. The rapid method of application, as developed by I. F. Huddleson and E. R. Carlson, who investigated Bang's disease at the Michigan State College of Agriculture, has broadened the scope of the test. This method permits the test to be read and its results recorded almost immediately after its application.

TREATMENT

Before the true nature of infectious abortions was well understood, it was natural to suppose that medicinal substances could be used to advantage in preventing animals from aborting. This view was so widely entertained and advanced for years that it has been difficult to be thoroughly convinced of its falsity. Testimonials relating to alleged medicinal cures or preventives have sometimes been so extravagant as to be alluring to the discouraged stock owner.

Medicinal substances for the treatment of this disease have gained their popularity, almost if not entirely, because they were used and their value was judged at a time when the disease had run its natural course. The administration of no drug or medicinal compound has proved to be effective in the cure or prevention of this disease.

Treatment in many cases should be given the aborting animal, particularly when there is retention of the afterbirth. Vaginal and uterine douches with nonirritant, antiseptic fluids or solutions of common salt, when properly made, seem to hasten recovery of the generative organs and frequently prevent subsequent barrenness. Treatment of this character, however, should be undertaken with the idea of washing the germs out of the generative organs and relieving inflammation, and not with the expectation that abortion germs will thereby be completely destroyed.

PREVENTION

The dependable information on the disease should be of particular interest and practical value to owners of herds into which the disease has not gained entry. It should not be very difficult to maintain such a herd once it is built up or assembled. Dairy owners who have recognized the importance of excluding the malady have demonstrated that it can be done.

There are reasons for believing that the disease is most commonly introduced into clean herds through the purchase of cows or pregnant heifers that carry the germs in their bodies. A cow with a calf by her side may be a spreader of the causative germs or may become a spreader later, since it is well known that infection of the afterbirth does not always result in the death of the fetus. Bulls and unbred heifers are less likely to spread the disease and may therefore be added to noninfected herds with less danger.

The feed supply offers another possible agent for spreading the disease. Roughage and grain, if produced on farms where Bang's disease exists, may be soiled with the discharges of infected animals and, when consumed, may transmit the disease. In some instances the infection is probably introduced through a pasture that receives drainage from a farm where the malady is present. There is also the possibility that animals pastured near railroads may be exposed by the scattering of contaminated bedding from stock cars. Unpasteurized milk from creameries or other sources may readily carry the germs to the farms where the milk is used.

It is highly probable, however, that the infected cow or the infected pregnant heifer is mainly responsible for the development of new centers of infection and that excluding them from a noninfected herd would usually mean freedom from the disease.

The serum tests have considerable value in enabling purchasers of animals to distinguish between the infected and the noninfected, but they have their limitations. Difficulties obviously confront the stock owner in keeping his herd free from the disease while adding to it stock from questionable sources.

CONTROL AND ERADICATION

Although the disease may be excluded from noninfected herds with reasonable care, it is much more difficult to eradicate it from infected herds. It is especially discouraging when the disease is running rampant and abortions are occurring frequently. Under these conditions animals may abort unexpectedly in many cases and scatter infectious material over wide areas before being discovered and separated from the rest of the herd. Success in dealing with the problem under these conditions is likely to involve considerable expense. On the other hand, if the disease is more quiescent, and comparatively few abortions occur, the problem of eradication may be greatly simplified.

It is doubtful whether any one method of dealing with infected herds is well adapted to the needs of every herd owner, and will deal satisfactorily with all degrees of infection. Several advantageous methods are, therefore, described.

TEST-AND-SLAUGHTER METHOD

The test-and-slaughter method is similar to the one used so effectively in the eradication of tuberculosis. This method involves the immediate disposal for slaughter of the animals which react to the test, and a thorough disinfection of the stables. In following this plan it is necessary that repeated tests of the herd be made at intervals of from 30 to 60 days, and that the same disposition be made of any subsequent reactors before they have had an opportunity to abort and spread the infection.

This method may prove costly in herds where the disease is making rapid headway, as the owner may find it necessary to dispose of many more animals than the original test indicated would be necessary. On the other hand, the test-and-slaughter method is likely to be successful and practical in herds having a low percentage of reactors, those in which the breeding or milk-producing value of the animals is not greatly in excess of their value for beef, and in herds in which the disease is only mildly active.

The use of the test-and-slaughter method should appeal also to purebred-stock owners who derive their profits principally from the sale of stock.

TEST-AND-SEGREGATION METHOD

Another method of dealing with infected herds is to subject the entire herd to the agglutination test and segregate the animals into two units occupying different premises. One unit is made up of reactors and the other of nonreactors to the test. This method often appeals to owners who find it impractical to dispose of reactors for slaughter. It can sometimes be practiced at no great additional expense to the owners, and enables them to eradicate the disease more gradually and in such a manner as not to affect profits seriously. The test-and-segregation method is especially appropriate in larger herds which have access to two or more buildings. Although the herd is separated in accordance with the results of the original test, it is necessary that the nonreacting unit be tested at intervals of from 30 to 60 days in order that subsequent reactors may be detected and promptly removed before they constitute sources of infection. A number of tests may be required to detect all the animals that harbor the germ or that acquire the disease.

This plan may be expected to result in a satisfactory increase in the size of the nonreacting unit, since calves may be added from both the reacting and nonreacting units. The success of the method depends largely upon the conditions for so handling the two units as to prevent the transfer of the infection from the diseased to the healthy animals.

The test-and-segregation method is not always practicable for owners of smaller herds. Facilities may not be available, or can be provided only at more expense than seems justifiable, for maintaining such herds on a 2-unit basis. Owners thus situated are inclined to be receptive to the extravagant claims made for alleged abortion remedies and place undue confidence in them.

SANITARY MANAGEMENT

Even though a herd owner is unable to take definite action in eradicating the disease along the lines just described, the situation is not hopeless. There is still another method of control, requiring only a slight outlay, that can reasonably be expected to reduce the losses which the uncombated disease usually exacts. This method is commonly referred to as sanitary management. It is based upon the idea that benefit can be derived from reducing, even though not totally eliminating, the degree of *Brucella abortus* exposure to which healthy animals in infected herds are normally subjected.

Sanitary management is not very popular since it is a more or less continuous undertaking requiring both vigilance and perseverance. Although it fails to insure freedom from abortion losses it frequently accomplishes highly beneficial results.

As mentioned, some of the known germ-bearing substances expelled by cows and heifers are the fetus, afterbirth, and uterine fluids for a limited period following abortions, and the milk for prolonged periods. The germs are also expelled in the seminal fluid of infected bulls and in the feces of the calves of infected cows. It is also well known that cows that appear to calve normally may expel afterbirths and uterine fluids saturated with the causative germs. Knowledge of these facts, and the fact that animals may readily acquire the disease through the digestive tract, suggests the following recommendations for preventing by sanitary management the spread of the disease in infected herds.

Make frequent observations of all animals for symptoms of aborting, such as swelling of the external genitals or udder enlargement, and when such an animal is discovered place her immediately in a separate stall well away from other stock. If an abortion occurs unexpectedly, isolate the animal in the same manner as soon as the discovery is made. Bury or completely destroy the fetus and afterbirth if the latter has been expelled. Clean and apply disinfectant solutions to areas that may have been contaminated by the abortion products.

Place all pregnant animals in individual stalls a week or 10 days before calving and confine them to their calving quarters for a month following calving and as long afterwards as uterine discharges can be detected.

Clean and disinfect the maternity stalls before placing pregnant animals in them; otherwise they may constitute sources of infection. Avoid carrying germ-laden material from maternity stalls to other parts of premises on hands or clothing. The footwear of the attendant should be well scrubbed with a disinfectant solution after he has been in an infected stall.

Refrain from breeding cows for at least 2 months after calving or aborting. Bulls serving cows after such an interval should rarely if ever acquire the disease thereby or contaminate their generative organs with the causative germs.

Keep aborting animals isolated for a period of from 6 weeks to 2 months. Cows with uterine discharges should always be kept away from the rest of the herd, whether they have aborted or not, until they have recovered.

Dispose of the bedding used by infected or suspected animals in such manner as to render it inaccessible to stock that is free from the disease.

Use care in the management of the bull. Do not permit him to run with the herd or to serve cows on lots that are occupied by stock free from Bang's disease. Although the disease may seldom be transferred by the act of service, the discovery that infected bulls may eliminate the causative germs in their semen makes it plain that such bulls may be capable of contaminating their environment, which would then become a menace to stock free from the infection. Bulls giving marked reactions to the abortion tests should not be used for service. Even though danger of spreading the disease thereby may be slight, such reactions strongly suggest infection of their generative organs. The reproductive power of such animals may be greatly impaired if not destroyed.

The best results from sanitary management have been derived in those herds to which no cows or heifers other than those produced in the herd were added. There are reasons for believing that the introduction even of animals that have never come in contact with the germs may be a detriment. Such animals may acquire the disease more readily than those raised within the herd, and there is also a strong probability, when highly susceptible animals become infected and abort, that their products of abortion are more heavily infected with the causative germs than are the same substances from animals that may have previously developed some degree of resistance to the malady. These factors, in all probability, are responsible for some of the discouraging results obtained by those who have endeavored to control the disease in their herds while adding to them by purchase rather than by developing their own stock.

HANDLING YOUNG STOCK IN INFECTED HERDS

The care of the growing stock in infected herds is important. The germs are not known to localize in the bodies of young calves. When calves harbor the infection in their bodies at birth it is usually overcome in a reasonably brief period. Heifers, as they approach breeding age when running with infected cows, occasionally acquire the malady, and after conception the danger is increased to a marked degree. Better results consequently may be expected when heifers are separated from the infected stock during their first pregnancy.

VACCINATION

There are certain infectious diseases to which domestic animals become resistant after sustaining one attack. This acquired resistance is commonly referred to as immunity. In some diseases investigators have learned to impart such or similar resistance in an artificial manner so that the animal acquires the resistance without suffering an attack of the disease. Much experimental work has been directed toward devising a successful method of producing immunity against Bang's disease.

Vaccines, bacterins, and serums have been used. Abortion vaccine contains living abortion germs; abortion bacterin, the germs which have been killed; and abortion serum, the fluid portion of the blood of animals that give a marked reaction to the abortion tests. The customary practice is to inject one of these substances beneath the skin of the animal that is to be rendered immune.

Numerous investigators who have studied the value of these substances have arrived at the conclusion that the benefit derived from the use of bacterin and serum is not sufficient to compensate for the labor and expense involved in their administration. Abortion vaccine, on the other hand, has yielded encouraging results and may have considerable practical value in combating the malady.

The results of earlier experiments indicated that when abortion vaccine was administered to unbred stock the living abortion germs which it contained did not long remain active within the animal. Later experiments revealed that although the germs rarely became established in unbred, vaccinated heifers, they occasionally invaded the udders of unbred, vaccinated cows. These infected cows eliminated the abortion germs in their milk.

In an endeavor to overcome this objectionable feature, experiments have been conducted in which vaccines prepared from *Brucella abortus* strains of reduced virulence were used. In addition to the effects of vaccination in connection with unbred heifers and unbred cows that received the vaccine at least 2 months before their breeding, the effects of vaccinating calves from 4 to 8 months of age have also been investigated. The results of these investigations have thrown additional light on the subject of vaccination.

There is evidence to indicate that vaccine prepared from *Brucella abortus* strains of low virulence, whether administered to unbred, sexually mature cattle, or during calfhood, greatly reduces the danger of establishing the infection in them and at the same time affords a serviceable degree of resistance against the disease.

Since abortion vaccine contains the living causative germs, it should never be used except in herds where the disease is definitely known to exist; otherwise new centers of the infection may be established. Pregnant animals should never receive abortion vaccine of the kind prepared at present, since it would be likely to transmit the disease to them rather than act as a preventive. It seems advantageous to refrain from breeding vaccinated animals for at least 2 months after the vaccine has been administered.

Vaccination is by no means a solution of the problem of abortion control. Little or no evidence has been obtained indicating that it benefits animals which have already acquired the disease and are carriers of the causative germs. There are, moreover, reasons for believing that the animal which has sustained an attack of the disease but is no longer a carrier is more resistant to reinfection than she could be rendered by vaccination. Thus the usefulness of vaccination may be limited to animals which, up to the time of treatment, have escaped the disease or that give negative results to the abortion tests. Vaccination seems to be a more appropriate treatment for unbred heifers than for unbred cows, not only because of their tendency to resist permanent infection more successfully but also because unbred heifers, even though raised in an abortion environment, rarely give evidence of having contracted the disease.

Since the use of abortion vaccine seriously complicates the interpretation of the agglutination test of animals, its use in herds is not desirable until all intention of making use of the test-and-slaughter or test-and-segregation methods is abandoned. The use of abortion vaccine furthermore is objectionable in dairy herds where the dairy products are not pasteurized, because of the human-health aspect of the problem.

The immunity that may be imparted by vaccination has not given evidence of always being sufficient to afford complete protection against the disease. Therefore sanitary management should be practiced when efforts at immunization are attempted.

RETAINED AFTERBIRTH

Retention of the afterbirth is a common condition in herds where Bang's disease prevails. Owners are frequently at a loss to know what to do when this occurs. Since the afterbirth of healthy animals often is not expelled until after a few hours, owners are justified in viewing its retention with little alarm until 24 hours after the act of abortion or parturition, provided the animal appears to be normal otherwise. Retention of the afterbirth longer than 24 hours signifies that inflammation of the uterus may be present and responsible for its adherence. When the afterbirth has been retained for 2 or 3 days its putrefaction usually becomes marked. In this putrefactive process within the uterus poisonous substances may be generated and absorbed by the animal, causing fever, loss of appetite, and other evidences of severe trouble. Invasion of the blood stream by the bacteria may terminate fatally.

The afterbirth is frequently removed before putrefaction is excessive by reaching into the uterus with the hand and separating as carefully as possible the attached areas and flushing the organ out afterwards with mild antiseptic solutions or warm salt water. A 0.5 percent Lugol's solution[1] is often used for this purpose. Boiled water which has been permitted to cool to body temperature and to every gallon of which one heaping tablespoonful of table salt has been added makes a satisfactory irrigating fluid.[2] The flushing may be done by the use of a soft-rubber tube with a diameter of about half an inch, to which a funnel is attached. The fluid should not be allowed to remain long in the uterus, but should be siphoned out by lowering the external end of the tube when filled with the fluid.

The afterbirth can seldom be removed by hand without causing some injury to the uterine walls, a factor that renders the operation of uncertain value. A putrefactive afterbirth in contact with injured uterine walls may readily be more harmful and more likely to kill the animal than is its contact with an uninjured uterine surface.

A less drastic method is consequently often advisable. This method permits the afterbirth to remain attached to the uterine walls, while by introducing mild antiseptic substances into the uterus the rapid multiplication of germs is prevented until the membranes come away of themselves. Separating the pendent portion of the afterbirth from the retained part about 6 or 8 inches exterior to the vulva is a means of reducing the contamination of surroundings. A dram (level teaspoonful) of iodoform combined with a quart of mineral or olive oil and introduced into the uterus through a rubber tube is recommended. The milk of animals so treated may have an iodoform odor for several days and therefore should not be used for food. Such irrigating fluids as those mentioned for washing out the uterus after removal of the afterbirth by hand may be used, but seem to be less efficient than iodoform and oil. It is seldom advisable to introduce irrigating fluids more often than once a day or once in 2 days. Although animals have been known to retain the afterbirth for as long as 10 days after a single administration of iodoform and oil, as described, they appeared to experience little discomfort or harm.

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[1] Lugol's solution of iodine is compounded as follows: Iodine, 5 parts; potassium iodide, 10 parts; and boiled water to make 100 parts. One part of this compound to 200 parts of boiled water makes a solution suitable for uterine irrigation. Lugol's solution may be purchased from any druggist.

[2] A 1 percent solution of common salt in boiled water at body temperature makes a suitable irrigating fluid. A heaping tablespoonful of dry salt weighs approximately 1 ounce, and this quantity in 1 gallon gives the proper strength.

Retention of the afterbirth is a more serious condition than often realized, since it may be followed by or induce barrenness. Because of this fact the assistance and experience of a qualified veterinarian are highly desirable.

STERILITY (BARRENNESS)

Sterility commonly gives much concern to the owners of herds infected with *Brucella abortus*. Although the abortion germ seems unable to thrive in the uterus of a cow for any great length of time, it seems indirectly responsible for a high percentage of barrenness because it induces in the uterus a condition that invites numerous other types of germs more permanent and destructive. Sterility troubles may logically be expected when cases of retained afterbirths are treated carelessly.

Sterility may result from bacterial infection of the vagina, the uterus, or the tubes that convey the ova from the ovaries to the uterus. Diseased conditions of the ovaries also may interfere with conception or with regular heat periods. Sterility may furthermore be the result of incomplete development of certain of the generative organs. Determination of the cause is not always possible.

Herd owners can prevent the trouble to some extent by limiting the spread of Bang's disease as well as by making sure that all cases of retained afterbirth receive proper attention. Every long-standing case of sterility is a study in itself, and should be intrusted to the care of a veterinarian when the value of an animal justifies such a procedure. Appropriate treatment in individual cases can be determined only after a careful examination of the generative organs. Although it is not always possible to eliminate diseased conditions when they have been found, professional advice on the outlook for recovery is frequently of value to the owner because it enables him to dispose of hopelessly sterile animals promptly.

Failure of cows and heifers to conceive is sometimes the result of their being mated with bulls that are weak sexually. Owners are cautioned against considering cows to be permanently sterile until they have been bred several times to a bull of known fertility, for it is by no means unusual in herds infected with Bang's disease to have cows conceive on the fourth or fifth service, even without treatment.

INFECTIOUS ABORTION IN ANIMALS OTHER THAN CATTLE

Abortion troubles, although of more economic importance in cattle than in other animals, frequently give the owners of horses, sheep, goats, and swine considerable concern.

In horses a germ known as *Bacillus abortivo-equinus*, which has characteristics different from those of *Brucella abortus*, has given evidence of being largely responsible for abortion although in rare instances abortion has been caused by *Br. abortus* (bovine) which commonly affects cattle, and *Br. abortus* (porcine) which commonly affects swine. The type of infectious abortion most common in horses can be diagnosed with reasonable accuracy by means of blood tests. The use of equine abortion bacterin as a preventive agent has given evidence of being beneficial in the control of the disease.

In sheep, a germ called a spirillum or vibrio has appeared to be mainly responsible for abortion losses although abortion outbreaks due to *Br. abortus* or *Br. melitensis* have also been reported in other countries. The disease in sheep does not appear to prevail widely or to be of great economic importance, at least in North America.

Infectious abortion of swine causes serious interference with the swine industry, especially in those sections where hogs are raised in large numbers. It is caused by a germ known as *Brucella abortus* (porcine), which is closely related to *Br. abortus* (bovine), but is not identical with it. Swine can readily be infected with the disease through the digestive tract and are believed to acquire the disease commonly by consuming materials such as fetuses, afterbirths, and uterine discharges, expelled by infected swine.

The act of abortion as a symptom of the disease does not appear to occur so frequently in swine as in cattle, and the disease has shown evidence of being self-limiting to a greater degree in swine than in cattle.

Although the germ which causes the disease in swine is closely related to that affecting cattle, swine have not been shown to contract the disease from infected cattle.

An agglutination test of the blood of swine is a means of detecting the disease in this species. The test has been used to some extent as a basis for control and eradication efforts.

BRUCELLA ABORTUS AND HUMAN HEALTH

Infection of the udders of cows with *Brucella abortus* and the possible presence of the germs in the milk have received more attention during recent years than formerly because of the discovery that the organisms sometimes affect human health.

For several years after it was found that *Brucella abortus* affected cattle and swine, it was generally supposed that no special precautions were necessary to prevent their causing human disease. Experimental studies had strengthened this belief. When it was discovered that *Br. abortus* of both the bovine and swine types was closely related to *Br. melitensis*, the type known to cause disease in both goats and man, investigators suspected that *Br. abortus* (bovine) and *Br. abortus* (porcine) might also produce disease in man. Evidence was not obtained immediately, but in the course of time a few cases of human illness were traced to the effects of *Br. abortus*. Undulant fever, caused by *Br. abortus* (porcine) and *Br. abortus* (bovine) has now been recognized in many sections of the United States and in numerous other countries. Human beings are believed to acquire the disease occasionally when caring for infected swine or cattle, particularly swine. The fetuses, afterbirths, and uterine discharges of affected animals are special sources of danger.

The disease is sometimes acquired by human beings through the consumption of raw milk from cows infected with *Brucella abortus*. Butter made from raw cream produced by infected cows has been known to harbor abortion germs.

Although the danger of contracting the disease through the consumption of dairy products from infected cows seems to be relatively slight, it should not be ignored. Pasteurization, however, renders milk safe for human consumption.

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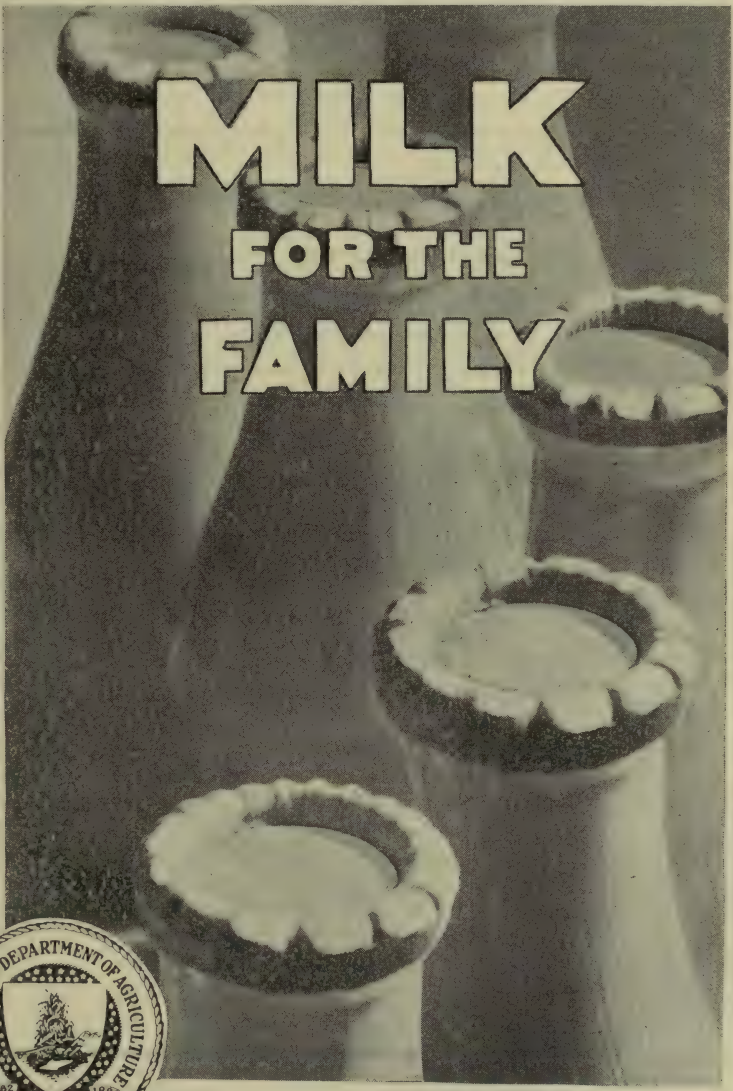

MILK FOR THE FAMILY

EVERY HOME MAKER SHOULD KNOW—

What milk contributes to the well-balanced diet
How much milk the family needs
Something about grades and quality of milk
Why milk is commercially pasteurized
What milk to select for the baby
How to care for milk and cream at home
The value of milk in its various forms
Many ways to use milk and its products

This bulletin supersedes Farmers' Bulletin 1359, Milk and Its Uses in the Home.

Washington, D.C. **Issued, July 1933**

MILK FOR THE FAMILY

By Rowena Schmidt Carpenter, *associate home economist, Bureau of Home Economics, in cooperation with the Bureau of Dairy Industry*

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THE CONSUMPTION OF MILK

MILK AND MILK PRODUCTS are important items in the diet of farm families in the United States. About 70 percent of the farms have one or more milch cows, and milk is available on most of these farms throughout the year. On farms producing milk, the quantity consumed per person per day averages about 1 pint of whole milk, the cream from about one half pint of milk, and about three fourths of a pint of skim milk and buttermilk. These are figures for 1932, based on averages for the country as a whole. They do not include the large quantity of cream used on the farm for making butter.

The relative quantities of whole milk, cream, skim milk, and buttermilk, as well as the total quantity of dairy products consumed on farms, vary considerably with the section of the country and with the individual family. Whole milk is used most liberally in those States where the milk is low in fat content. The use of cream increases on farms as elsewhere in times of prosperity. On most farms where skim milk is available, considerable quantities are used to drink, in cooking, and for making cottage cheese. Skim milk takes a place of great importance in the farm diet when incomes are low and families must economize closely.

In cities and villages the consumption of milk averaged about nine tenths of a pint per person per day in 1931. The figures on which this average is based were collected by city boards of health and summarized by the Bureau of Agricultural Economics, and include milk from which only the cream is used. During the same year the average quantity of evaporated milk used was about six tenths of an ounce per person per day, and of condensed milk, about one tenth of an ounce.

Selling market milk in half-pint bottles has done much in recent years to encourage the drinking of milk away from home. The amount of milk ordered with meals over lunch counters, in restaurants and dining cars, school cafeterias, and hotels has increased. Also it is now common for men working indoors and out to drink milk with their lunches.

THE MILK QUOTA

Milk in some form might well furnish one fourth of the total calories used by the average American family. In terms of money value, from one fifth to one third of the allowance for food should be spent for milk and its products. An outstanding nutrition chemist says that whatever amount of money is available for the family's food, it is wise to spend at least as much for milk (including cream and cheese if they are used) as for meats, poultry, and fish.

The quantity of milk each person needs depends upon physical maturity, the variety of the diet as a whole, and any special needs, such as those of pregnancy. A generous daily allowance is 1 quart (or its equivalent in other dairy products) for every child, 1 quart for every pregnant or nursing woman, and 1 pint for every other adult. This includes milk used in food preparation as well as milk taken as a beverage.

If, because of limited stomach capacity or for some other reason, a child finds it difficult to take such a generous quota of milk even when part of it is used in preparing his food, then undiluted evaporated milk or a concentrated solution of dried milk may be used in cooking for him (p. 24). In varied diets, when milk is carefully supplemented in nutritive value by other foods, three fourths of a quart of milk daily may be adequate. Every growing child needs at the very least a pint a day, and an adult at least one half a pint. These very limited allowances do not fully meet the need for calcium, and the remainder of the diet should be selected with this fact in mind.

Families on low-cost diets need a generous milk allowance. They need the daily quart for each child and the pint for each adult. The less money there is for food, the more likely is the diet to be limited in variety and the more important that the whole family use plenty of milk and its products. In low-cost diets, either dried or evaporated milk may be used instead of fresh milk when these forms are less expensive.

NUTRITIVE VALUE

Milk contributes more to good nutrition than does any other single food. It has no equal among foods as a source of calcium, and is valuable also for other materials necessary throughout life. When taken in suitable quantities, milk is a dependable source of calcium, phosphorus, protein, vitamin A, and vitamin G. Milk contains also appreciable quantities of other vitamins and minerals. About two thirds of the solids of milk consist of fat and sugar, which are sources of energy. The solids in milk total nearly 13 percent, a fact often lost sight of because milk is a liquid. Many foods that are "solid" in form contain less solids and more water than milk.

Because milk reinforces the diet in so many different ways, it is the soundest foundation on which to build wholesome meals for the family. Milk is valuable for maintenance in adults and for growth in children. Children's diets lacking or low in milk are almost always defective unless carefully supervised by a nutritionist who selects other foods that replace milk in nutritive value. Though this is possible, it is not easy. The simplest and safest way to provide the dietary essentials and to insure normal growth is to make milk the basis of the child's diet.

Milk is used to the best advantage when taken in combination with other foods. There is no perfect food that can alone fill all of the needs of nutrition, and though milk contains all of the nutrients of a balanced diet, they are not all present in ideal proportions. Milk cannot be depended upon for an adequate supply of some of the vitamins. The fuel or energy value of milk is insufficient for the adult. He would have to take 5 or 6 quarts of milk each day to meet all of his need for energy, and would meantime be taking unnecessary quantities of protein. Everyone except very young infants requires food richer in iron than milk is. Most healthy persons beyond babyhood require food containing a certain type and quantity of indigestible material to supply the bulk necessary to keep their digestive tracts in good condition. This material is not in milk, but is found in fruits and vegetables. For these reasons milk is supplemented by other foods very early in life, according to the best practices in infant and child feeding.

PROTEINS

Proteins are important building materials needed for the muscles and all other body tissues and fluids. They may serve also as fuel for the body. A certain quantity of protein is required every day for the upkeep of the human structure even in adult life, but the need is greatest before growth is completed. Many kinds of protein are found in foods. Milk contains two kinds, the principal one being casein, and the other lactalbumin, present in smaller quantities.

Proteins contain nitrogen, and all are made up of compounds known as amino acids. The combinations of amino acids found in the proteins of milk, eggs, meat, and other flesh foods are similar to those in the human body. For this reason these proteins are of special value for tissue building, and are called complete or efficient proteins. None is more efficient for growth and maintenance of the body than are the casein and lactalbumin of milk, and few foods supply efficient proteins at so low a cost as milk. This is especially true of skim milk, whether bought in liquid or in dried form.

SUGAR

Milk contains lactose, a sugar belonging to the group of nutrients called carbohydrates. Lactose is made commercially from the whey of milk used in the manufacture of casein, and is marketed in both granular and powdered forms.

Like cane and beet sugars, lactose supplies energy to the body, but it is not so sweet and has less tendency to ferment and to irritate the stomach. Lactose has an important influence on the kind of bacteria found in the intestines. It favors the growth of lactic-acid bacteria and other desirable types, and makes conditions unfavorable for putrefactive bacteria, often present in excessive numbers in the intestinal tract. For this reason the patient who is put on a buttermilk or an acidophilus-milk diet is often advised to take several ounces of lactose daily. Another value of lactose is its somewhat laxative action. It is used to some extent in modifying milk for babies.

FAT

Whole milk contains fat in the form of small round droplets or globules, suspended as a natural emulsion. These globules are lighter than water and tend to rise to the top of the milk as it stands, forming a cream layer. From the commercial standpoint much of the value of milk lies in its fat content, often called butter fat, which may be separated and sold as cream, made into butter, or used in making certain cheeses. From the standpoint of nutrition, the fat of milk has special value, due to the presence of vitamins A and D. These vitamins are soluble in the fat and remain combined with it; therefore they occur in whole milk, cream, butter, and in cheese made of whole milk, but only to a very small extent in skim milk and its products and buttermilk. Due to its low melting point and emulsified form, milk fat is more easily digested than most fats. It is valued, too, for its pleasing flavor.

Because fats are the most concentrated sources of energy, the percentage of fat in milk influences its fuel value, or the number of calories it yields. Whole milk varies in fat content with the breed of cow and other factors, but averages about 3.9 percent. The quantity of fat in skim milk, buttermilk, cream, and butter is discussed in the section on milk products. However, the importance of milk fat in nutrition is as much a matter of its nutritive quality as of the quantity.

MINERALS

Calcium, phosphorus, and iron, three of the many minerals required by the body, demand special attention in planning the diet because they are not abundant in all foods. Milk, either whole or skimmed, is the most practical source of calcium known, and is a good source of phosphorus. Iron, necessary in the formation of red blood cells, occurs only in small quantities in milk, though what iron there is in milk is readily used by the body. Beginning early in infancy some iron-rich foods must be provided to supplement milk.

Phosphorus is needed in the make-up of every living cell, whether of the bone, tooth, muscle, or nerve tissue. Calcium is the chief mineral constituent of the bones and teeth, and an abundant supply of it is essential for their growth. Bone and tooth tissues can develop and harden normally only when calcium and phosphorus are taken in good relative proportions in the diet, and when certain of the vitamins are also present.

The urgent need for phosphorus and calcium begins in the human being about 7 months before birth, when the number of cells is multiplying rapidly and the bone structure and tooth buds have begun to form. This need increases during the last weeks before birth when calcium is stored at a rapid rate by the developing skeleton. By the time the child is born, all of the crowns of his first teeth are formed in his gums, and four of his permanent teeth are partly developed in his jaws. The large demand for calcium during prenatal life and infancy is one reason for emphasizing the recommendation of a quart of milk a day for the pregnant and the nursing woman. During these two periods the woman must provide for her own calcium needs at the same time she meets the requirements of the developing fetus and later of the growing infant. There was some foundation for the old idea that each child cost his mother a tooth because diets often did not contain sufficient calcium for both mother and child, and nature drew on the supply for the child first. This left the mother so depleted in calcium that her teeth were likely to soften or show decay.

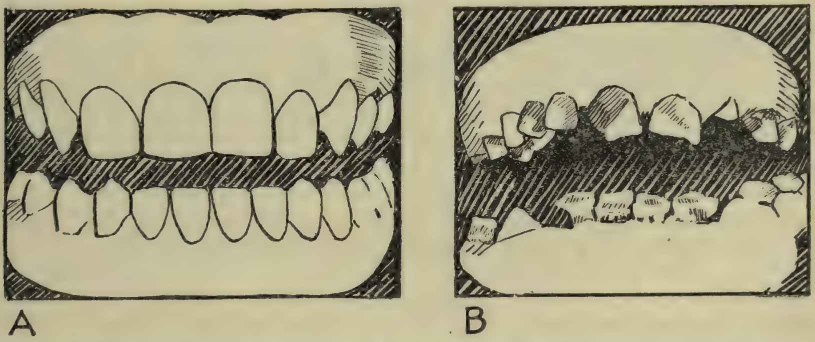

FIGURE 1.—The effect of diet on tooth-building. A, Sound, hard, healthy, well-constructed teeth of a boy of 15 years who had the proper tooth-building materials. His mother's diet during his prenatal life was well balanced, and his first teeth were sound. B, Porous, soft, decayed, irregular teeth of a boy of 10 years who never had the proper tooth-building materials. His mother's diet during his prenatal life was deficient, and his first teeth were poor. (Drawings adapted from photographs furnished by the Forsyth Dental Infirmary for Children, Boston, Mass.)

During all the years of growth, the teeth are seriously affected by a diet low in calcium. They may fail to develop properly, they may not harden or calcify, and they may develop cavities. The influence of diet on teeth is often observed at children's clinics and in schools and institutions where food-habit records are taken in connection with regular health examination (fig. 1).

Repeated observations on children show that improving the diet in minerals and in certain vitamins checks the development of any tooth cavities that are started and prevents the beginning of new ones. Milk is always prominent in these corrective diets.

Throughout childhood, until all of the permanent teeth are erupted and the bone growth is completed, a daily milk quota of at least three fourths of a quart and preferably a whole quart is almost essential to insure the necessary calcium. With an inadequate supply of calcium and phosphorus, the bones may be stunted or may develop some of the deformities of rickets; with a liberal supply the body can build sturdy and healthy bones and teeth. The extent to which an individual attains the height set for him by heredity is influenced to a marked degree by the quantity of bone-building materials taken during the growing years. This is true also of the normal development of the jawbone and dental arch, which must grow properly if the teeth are to be well-spaced and regular in shape.

The need for calcium and phosphorus to keep the teeth and bones healthy continues throughout life. What has been said of cavities in children's teeth is true also to a large extent of those in adults' teeth. One of the principal reasons for calling milk an essential whole-family food is the difficulty of meeting calcium needs unless the diet of everyone includes some milk each day.

VITAMINS

Vitamins are substances in food that are necessary for good nutrition, though they are neither building materials nor sources of energy. They fall in the class of body regulators, and are better described in terms of what they do than of what they are. Vitamins as a group promote growth and make for health and vigor. Separately they provide resistance to certain infections, are responsible for normal bone and tooth development, stimulate a good appetite, and protect the body from " deficiency diseases " such as xerophthalmia, beriberi, scurvy, rickets, and pellagra.

With the exception of rickets and pellagra, typical cases of deficiency diseases are extremely rare in this country. Many persons, however, are below par in physical development and general health because their diet is just short of the quantity of certain vitamins needed for complete protection. Badly formed or decayed teeth, rickets, sluggish digestive systems, listlessness, and lowered resistance to many infections are often indications of a diet low, though not lacking, in several vitamins. To protect the body from conditions such as these is just as important a function of vitamins as to prevent the more conspicuous diseases named above. No single vitamin or single food can offer complete protection, but foods rich in vitamins and in certain minerals are called " protective foods " because of their everyday contribution to good health.

Whole milk is one of the important protective foods partly because each of the six vitamins so far discovered, A, B, C, D, E, and G, has been found in it, in large or small quantities. Two of the vitamins, A and G, occur abundantly in milk. Since no food is an excellent source of all six vitamins and few foods contain even small quantities of all of them, the vitamin content of milk is unusual and gives it a unique place among foods. However, most nutritionists agree that in addition to milk, other sources of vitamins B, C, and D should be provided in the diet to safeguard nutrition, especially in infancy.

VITAMIN A

Whole milk—fresh, dried, or evaporated—cream, butter, and cheese made from whole milk, or milk enriched with cream are excellent sources of vitamin A. This vitamin is necessary for normal growth, sound tooth structure, vitality throughout life, and reproduction. Vitamin A also keeps body tissues healthy, and in this way tends to increase resistance to bacterial infections such as those of the sinuses, throat, ears, and perhaps kidneys. A long-continued lack of this vitamin causes the eye disease xerophthalmia, with eventual blindness.

Fortunately the body can store a supply of vitamin A, and an abundance at one time may be of value later if for some reason the diet is low in it. However, during childhood, pregnancy, and lactation, it is safest to provide this growth-promoting vitamin constantly and generously.

The amount of vitamin A found in milk and its products depends somewhat on the type of feed and somewhat upon the breed of the cow but, in general, dairy products are considered rich sources. The vitamin A content is always high in milk from cows on green pasture, and may be kept up during the winter months if the feed is wisely selected. Modern dairy practices tend to maintain high nutritive value in milk especially in vitamin and mineral content.

Vitamin A is associated with the fat of the milk, so cream and butter are more concentrated sources than whole milk; skim milk, buttermilk, and skim-milk cheese have very much less vitamin A than whole milk. Commercially skimmed milk has very little. This vitamin is less easily affected by heat and oxidation than most others, which is the reason that whole-milk cheese and boiled, dried, canned, and pasteurized milk still retain a large part of their original content of vitamin A.

VITAMIN B

Milk is a fair though not rich source of vitamin B. Vitamin B stimulates the appetite and maintains normal muscle tone. Sluggish digestive tracts, nervous irritability, and the muscular paralysis of beriberi are due to insufficient vitamin B. This vitamin also influences the quantity and quality of human milk. Expectant and nursing mothers and growing children are particularly in need of vitamin B.

Since vitamin B is not stored to any extent in the body, a constant supply is necessary. Though the quantity in milk is not large, the daily use of an abundance of whole or skim milk, to drink and in cooking, makes it a fairly good source of this vitamin for most children and adults. Furthermore, the variety of fruits and vegetables and whole-grain products that should be included in the mixed diet beyond infancy usually brings the vitamin B content up to an adequate level. For nursing mothers, however, foods should be selected with special attention to the quantity of vitamin B they contain. And in infancy when the diet is largely milk, it is important to provide definitely for extra vitamin B by giving fruit and vegetable juices and purees, to the breast-fed as well as to the artificially fed infant. Some specialists consider it desirable to give also extracts of wheat or corn germ, or rice polishings, or yeast to increase the vitamin B content of the young child's diet.

VITAMIN C

Raw milk contains only a small and variable quantity of vitamin C, and heated milk probably contains little or none. Yet vitamin C is essential for normal growth and stamina in children, and both adults and children need it for good tooth and gum nutrition. An extreme lack of this vitamin results in soreness and bleeding of the gums, decay and loosening of the teeth, fragility of the bones, and painful stiffness of the joints, which, are, together, the symptoms of the disease scurvy.

Vitamin C is not stored in the body. It is very easily destroyed by the heat used in ordinary cooking, except in such acid foods as tomatoes, so it is important to make sure that the diet contains vitamin C every day. A good many fruits and vegetables supply this vitamin if used raw. The richest sources are the citrus fruits, raw cabbage, raw turnips, and tomatoes—raw, cooked, or canned. The juice of oranges or tomatoes is given to very young infants, both breast and bottle fed, to supplement the small and uncertain vitamin C content of milk.

VITAMIN D

The fat of milk normally contains a small quantity of vitamin D, which becomes significant in the diet when whole milk, cream, butter, cheese, and ice cream are used liberally. Vitamin D is valuable throughout life, but is especially important for children in the normal development of their teeth and bones. Without enough vitamin D, rickets may occur and much of the bone structure may be malformed or stunted.

For vitamin D during infancy and early childhood, milk needs to be supplemented with foods rich in vitamin D. There are only a few good natural sources of this vitamin; egg yolk is one, and cod-liver oil is an especially rich source. Both egg yolk and cod-liver oil contain vitamin A also, and are important foods for children.

Vitamin D can be produced by ultraviolet rays acting on a substance called ergosterol. A number of foods and the skin of humans and animals contain ergosterol. Its presence in the human skin accounts for the action of sunshine and artificial sun-bath treatments in preventing and curing rickets and in promoting general good health. Vitamin D is stored in the body, so some of the value of sunlight in the summer carries over into the winter.

Exposing foods to the rays of an ultraviolet lamp is called irradiation. Some dried milks are treated in this way and labeled "irradiated" on the container. They are better in antirachitic properties than fresh milk usually is. In a few localities fresh milk, too, is enriched in vitamin D by irradiation, or by putting vitamin D substances directly into the milk. Other means of producing milk rich in vitamin D are to feed the cows irradiated foods or to irradiate the cows themselves. Milk increased in vitamin-D content by one or another of these methods is now sold by a few dairies. This means that it is enriched in vitamin D only, and cod-liver oil rich in vitamin A as well as D may still be needed in the child's diet.

VITAMIN E

Vitamin E occurs to a small extent in the fat of milk, but is so widely distributed in nature that there are many sources better than dairy products. Essential for reproduction, vitamin E is known as the antisterility vitamin.

Vegetable oils, especially the one in the wheat embryo, are among the foods rich in vitamin E. Green lettuce and a number of other vegetables contain considerable quantities, so the limited vitamin-E content of milk is easily supplemented in the diet.

VITAMIN G

Milk, whole or skimmed, is one of the most valuable sources of vitamin G. This vitamin is of daily importance to everyone because it affects not only growth but also health and well-being at all ages. Foods rich in vitamin G help to prevent pellagra, a disease characterized by great decrease in strength, loss in weight, dizziness, indigestion or nervousness or both, and a definite type of skin lesions.

Skim milk, either fresh or dried, buttermilk, and cheese made from skim or whole milk are valuable for their vitamin-G content. Cooked, canned, and dried milk are as good sources as fresh milk, since vitamin G is not readily destroyed by heat.

EFFECT OF HEAT ON NUTRITIVE VALUE

Heat may make some chemical changes in milk, whether applied in food preparation or in destroying bacteria or in making milk curd more digestible for infants. The heat used in cooking, boiling, pasteurizing, drying, or canning milk has no appreciable effect on vitamins A and G, the two in which milk is especially rich. The person who eats a well-balanced diet supplying the other vitamins can therefore disregard the effects of heat on the vitamins in milk.

Heating causes the coagulation of a small proportion of the protein and the precipitation of some of the calcium salts. These changes and the losses they cause are slight.

Milk is not constipating as is sometimes suggested; it is merely not laxative because it is so completely digested that it leaves no coarse waste material in the intestinal tract. Boiling has no effect on this property. Babies may need honey or one of the other laxative forms of sugar added to their milk formula. The older child and the adult with plenty of cellulose-rich foods have an abundance of refuse from sources other than milk. On the whole, any seemingly undesirable changes caused by the heating of milk are minor when the protection to health and other advantages are considered.

BACTERIA IN MILK

Milk contains a few bacteria even as it leaves the udder of a healthy cow. But by careful control of sanitation it is possible to produce clean milk that contains relatively few bacteria. Clean healthy cows, clean healthy milkers and helpers, clean covered utensils, and prompt and efficient cooling of the milk are four essentials for the production of clean milk, low in bacteria.[1]

There are many kinds of bacteria, some useful and others harmful. The most common types in milk are those that cause it to sour by converting the milk sugar—lactose—into lactic acid. This change is valuable as a natural method of temporarily preserving milk from putrefaction, and is important in the making of butter and cheese. Some other kinds of bacteria, as they develop, change the color or flavor of the milk, or make it slimy or ropy. Still others, though they seem to have no effect on the milk itself, spread disease. The milk from tuberculous cows, for instance, is not a safe food to take raw because it may contain the bacteria of tuberculosis. Undulant fever in man is sometimes contracted by drinking raw milk from cows having the germs of abortion disease in their udders. Milk from cows that have not been examined for these diseases should be either boiled or pasteurized before it is used.

Bacteria get into milk in a number of ways—from the body of the cow, flies, insanitary utensils, or from persons who often unknowingly carry the bacteria of typhoid fever or diphtheria without themselves being ill. Epidemics of typhoid fever, diphtheria, and septic sore throat have been traced to contaminated milk from a single farm, mixed with the output of other farms.

The same chemical constituents and physical properties that recommend milk as a human food make it an excellent food for bacteria. A single bacterium in milk may increase manyfold in a few hours if the temperature and other conditions are favorable to bacterial growth. Temperatures from 70° to 100° F. are the most favorable for many organisms. Bacteria are very sensitive to heat and cold, a fact of great importance in the handling of milk from the dairy barn to the dining-room table.

COOLING AND PASTEURIZATION

Low temperatures, 50° F. or below, check the growth of bacteria. In modern dairy practice, milk and cream are chilled as soon as possible after milking.[2] As now distributed, milk is from a few hours to as many as 72 hours old before it reaches the consumer. Milk that has not been promptly cooled and kept cold may sour quickly, as it does often in summer between the dairy and the home. Even when there is no evidence of souring, milk that has not been kept cold may contain large numbers of bacteria much more unfavorable in type than those that cause souring.

Temperatures at or above the boiling point of water (212° F.) destroy most bacteria in a very short time, while temperatures around 140° F. are fatal to many bacteria if applied long enough. Heat sufficient to destroy all kinds of bacteria is likely to cause some changes in the chemical composition and the flavor of milk. To kill harmful bacteria, dairies heat milk at a rather low temperature in a process called pasteurization. The usual practice in commercial pasteurization is to heat the milk to at least 142° F., hold it at this temperature for 30 minutes, and then rapidly cool it. Many cities now require the pasteurization of all except certified and " special " milk before it can be marketed.

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[1] See Farmers' Bulletin 602, Production of Clean Milk.

[2] See Farmers' Bulletin 976, Cooling Milk and Cream on the Farm.

Pasteurization does not make milk entirely free from bacteria. However, when done by the best commercial method it destroys such disease-producing kinds as those of tuberculosis, undulant fever, diphtheria, septic sore throat, typhoid fever, and many others. Nor is pasteurization an insurance against future contamination. As great care should be taken of pasteurized milk as of raw milk (p. 15 to 17).

GRADES OF MILK

The organized effort to improve sanitary conditions for production and handling has helped to establish standards for grading milk on the basis of purity. The relation of insanitary conditions to the number and kinds of bacteria in milk and to the spread of disease makes milk standards essential. Especially in selecting milk for infants it is important to have established and dependable standards of purity for both raw and pasteurized milk of different grades in every community. The high standards of sanitation required for producing and handling some grades greatly increases their cost, so that not everyone can afford to use them. Furthermore, the highest grades are not necessary for all purposes. A series of grades of milk, each clearly defined and priced according to quality, allows the consumer to choose according to needs and pocketbook.

The methods of grading and the standards established for grades in various localities are not yet uniform. A milk ordinance which will encourage uniformity in methods of milk control has now been approved by the United States Public Health Service and the Bureau of Dairy Industry. The requirements for sanitation on the farm, in the milk plant, and on the part of each person handling the milk, and the definitions of grades according to these standards, are necessarily very detailed. Brief descriptions of the more important grades of milk as defined by the milk ordinance are given below, because a number of States and cities are now using this system of grading.

CERTIFIED MILK

Certified milk is raw milk of uniform composition and of a fixed and very high standard of purity. It is produced under excellent conditions of sanitation specified by the American Association of Medical Milk Commissions. It must not contain more than 10,000 bacteria per cubic centimeter of milk, and must not be more than 36 hours old when delivered. A local medical commission periodically inspects the cows, milkers, and buildings of dairies that are producing milk of certified quality; analyzes the milk; and issues a label or certificate for each approved dairy to use so long as it continues to meet the standards.

Local supervision may be handled by the medical society of the county, a representative of the State board of health, or the health officer of the city or county. The increased cost of producing certified milk justifies its market price, which is usually about twice that of ordinary good bottled milk. Certified milk should not be confused with so-called "sanitary" or "special" milk, since such terms have not been clearly defined and do not necessarily indicate exceptional purity or any other special equality.

GRADE A RAW MILK

Grade A raw milk has an average bacterial count not exceeding 50,000 bacteria per cubic centimeter at the time of delivery to the customer. The milk ordinance prescribes definite and detailed conditions of sanitation for the dairy farm producing grade A raw milk. Among the special requirements are rigid medical inspection of each employee of the dairy and tuberculin testing of the cows by a qualified veterinarian.

GRADE A PASTEURIZED MILK

Grade A pasteurized milk is grade A or grade B raw milk which has been pasteurized, cooled, and bottled in a milk plant that conforms to a number of specified requirements of sanitation. The average bacterial count of grade A pasteurized milk must not exceed 50,000 bacteria per cubic centimeter at any time after pasteurization until delivery to the consumer.

GRADE B PASTEURIZED MILK

Grade B pasteurized milk is grade C raw milk which has been pasteurized, cooled, and bottled in a milk plant conforming with all of the requirements for grade A pasteurized milk.

CHOOSING THE FAMILY MILK SUPPLY

Considering the country as a whole, high-quality milk of uniform composition is now available raw, pasteurized, evaporated, and dried. Wherever commercially pasteurized milk of high grade is available, it is likely to be the most widely used form. In food value it is practically the same as raw milk, and from the standpoint of health, it is much safer than most raw milk. The cheaper grades of market milk, raw or pasteurized, often just as high in nutritive value as the more expensive grades, may be used in cooking or for general purposes if food money is limited. They should be boiled for safety to health (p. 17). Canned and dried milk are now widely used, too, and because of their cheapness are a boon to low-cost diets.

The grade or form of milk to select depends partly on standards maintained by the local dairies, and partly on the family pocketbook. If there are young children, the family will buy whole milk in some form if money permits. To be able to choose wisely, every consumer should know what clean milk is according to medical standards, and what conditions are necessary for its production. For this reason a visit to the city milk plant or to a dairy farm from which the local milk supply comes direct, is of value. For unbiased information about local milk supplies, consumers may turn to the local health department. It is not the function of the health department to recommend a milk dealer, but to give information about bacterial counts, fat tests, and the sanitary conditions surrounding each milk supply in the community.

The best way for the consumer to buy market milk is in bottles, stoppered with tight-fitting caps. The type of cap that fits down around the sides of the rim is especially sanitary. Bottled milk can be kept both clean and cool during delivery more easily than loose or bulk milk which is transported in large cans and dipped out into another container when purchased. Dipped milk is a hazard to health because of the numerous chances for contamination during handling. Also, it may be deficient in cream, and it is subject to more chances for adulteration than is bottled milk.

MILK FOR INFANTS

Human milk is normally the best food for an infant, provided the nursing woman is healthy and is on a carefully selected diet which will richly endow her milk with vitamins. Human milk has the advantage of being very low in bacterial count, and it is also slightly laxative. However, there are instances when mother's milk is not available or when the child's condition indicates that the mother's milk is unsatisfactory. Under these circumstances, cow's milk is commonly used as a substitute. Goat's milk has been used with marked success in feeding some infants who have not thrived well on cow's milk.

In chemical composition, the milk of animals differs considerably from human milk, as is shown in table 1. Cow's milk, for instance, is much more concentrated in building materials than mother's milk, because it is secreted for the nourishment of the calf that normally increases its weight much more rapidly than does the human infant. Cow's milk contains about 2½ times as much protein and about 3 times as much mineral matter as human milk. The proportion of fat is about the same in both kinds, but cow's milk has much less sugar or lactose than human milk. These differences in percentage composition can, as a rule, be adjusted if necessary by adding water, some form of sugar, and sometimes fat, following reliable directions for modifying milk for infant feeding. Some infants, however, thrive better on plain cow's milk than on modified.

TABLE 1.—*Average composition of milk of various kinds*[1]

Kind of milk	Water	Protein (N×6.37)	Fat	Lactose (by difference)	Mineral matter (ash)	Fuel value per pound
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Calories*
Human	87.5	1.4	3.7	7.2	0.2	307
Cow	87.1	3.4	3.9	4.9	.7	310
Goat	87.0	3.3	4.2	4.8	.7	318
Sheep	82.6	5.5	6.5	4.5	.9	447
Reindeer	63.7	10.3	19.7	4.8	1.5	1,078

[1] Compiled by Food Composition Section, Bureau of Home Economics.

For infant feeding, the quality of milk is very important. If for a special reason a physician recommends raw milk for an infant, certified or other equally high-grade raw milk should be obtained. Grade A pasteurized milk is entirely satisfactory for babies, and is more commonly used because it is less expensive. Lower grades of raw and pasteurized milk may be used for infant feeding if necessary, but such milk should be boiled before it is made up in the formula. With dried and evaporated milk of high quality readily available, market milk of questionable quality should not be used in infant feeding.

SOFT-CURD MILKS

Some differences between cow's milk and human milk do not show up in percentage composition and cannot be adjusted by modifying the milk. They have to do with the size of fat globules and with certain characteristics of the protein. The latter is the more important because it influences the way in which milk is digested in the infant's stomach.

The protein of cow's milk is largely casein, which usually forms a solid, rather tough curd in the stomach when milk is taken by itself. The protein of human milk contains much more lactalbumin and coagulates in the stomach in a flocculent, tender curd. In infancy, when little except milk is put into the stomach, the hard curd of most cow's milk may markedly influence digestion, especially if the infant has a delicate digestive system. Also some invalids and convalescents who live largely on a milk diet have difficulty in digesting the hard curd of cow's milk.

The presence of the fat of milk tends to soften the curds for digestion. Whole milk has smaller and softer curds than skim milk, and " top milk " is still better in this respect. Heating changes the curd of milk and makes it more tender for digestion. Milk boiled directly over the fire for 3 minutes or more, and evaporated milk (because it is sterilized at a high temperature during canning), form a tender curd that behaves a good deal like human milk in the baby's stomach. Double-boiler-heated milk and pasteurized milk form a curd somewhat softer than does raw milk, but not so soft as does milk heated at the higher temperatures. Adding a thin cereal gruel or gelatin is another method of making milk curd more easily digested. These materials prevent the casein from coagulating in a hard mass. Dextrimaltose and glucose, forms of sugar widely used in infant feeding, also have a favorable effect on curd formation.

This matter of curd toughness, or " curd tension ", is such an important factor in the artificial feeding of infants that in recent years much has been done to find out whether this quality in cow's milk varies with the breed, the feed, or the individual cow. The results, very significant in infant feeding, show that in all breeds some cows give a soft curd and others a hard curd type of milk. Though curd toughness seems to be a characteristic of the individual cow, there is greater chance of finding cows giving soft-curd milk in some breeds than others. More Holstein-Friesian and Ayrshire cows give milk of low-curd tension than do cows of other breeds.

Practical tests for curd toughness have been developed and it is now possible for dairies and milk stations to obtain cow's milk of the soft-curd type and keep it separate to sell for feeding delicate infants and invalids. Some baby specialists believe that soft-curd cow's milk, because of its ready digestibility, is a suitable infant food without being modified. One of the principal reasons that goat's milk has been used so successfully in feeding delicate infants and adults with digestive disturbance is that it forms a tender curd in the stomach.

HOME CARE OF MILK

As soon as milk comes into the home the responsibility for keeping it clean, covered, and cold lies with the consumer. No matter how carefully milk is handled up to this point, it will not keep well if it is then carelessly treated. In the farm home, where milk is likely to be used within 12 hours after it is milked, the problem of caring for it differs somewhat from that in the city where the supply usually comes once in 24 hours and often from a great distance. Where facilities for keeping milk cold are not available, heating is important.

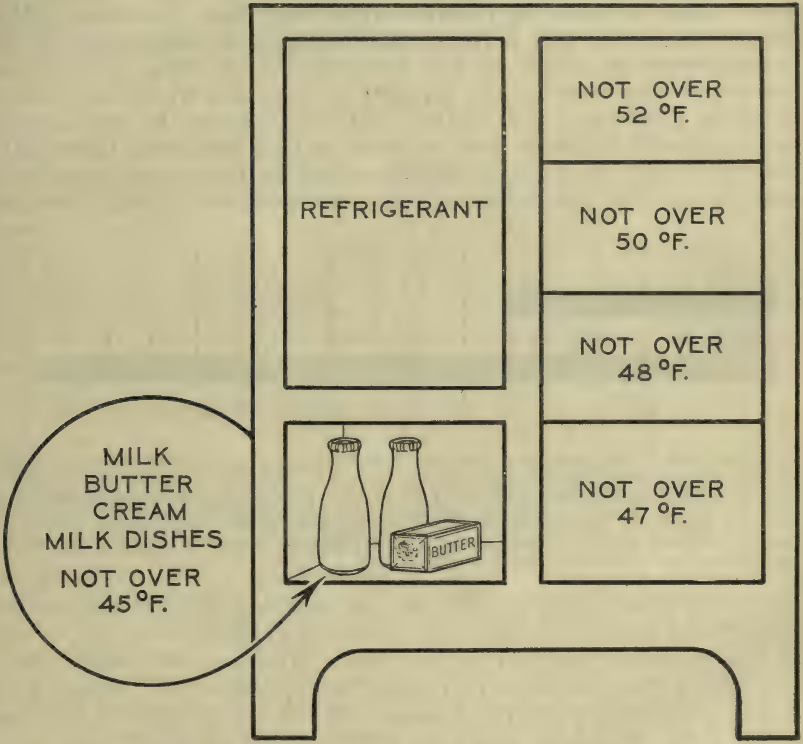

FIGURE 2.—Keep milk in the coldest part of the refrigerator, preferably where the temperature is not over 45° F. Test the temperature of the refrigerator to locate the coldest place.

RULES FOR CONSUMERS

1. Provide a cold, clean place in which to store milk. A refrigerator that holds a fairly constant temperature not higher than 45° F. in the milk compartment is ideal (fig. 2). Under such conditions milk and cream may be kept 24 hours or more. If kept at 50° or above for as long as 24 hours, milk and cream are very likely to be suitable only for cooking. A low temperature is especially important in keeping milk for infant feeding or milk for the family to drink.

Devise some other means to keep milk and cream cool if a good refrigerator of the ice or mechanical type is not available. Use a cold well, basement, or cellar for short-period storage of dairy products. In a dry climate an iceless refrigerator is satisfactory. It is seldom possible to maintain a temperature even as low as 50° F. in any of these devices. Buying milk and cream in small quantities and using evaporated or dried milk help to solve the problem of poor refrigeration.

2. Put milk and other dairy products into the refrigerator or cold-storage place as soon as possible after they are delivered. Milk standing on a sunny porch for several hours in summer may increase in temperature as much as 10° or even 15° or 20°. This causes a tremendous increase in the number of bacteria which no amount of chilling afterward will reduce. If milk cannot be refrigerated at once, ask the delivery man to leave it in a sheltered place or in a covered box. Many city dairies provide their customers with special boxes with hinged covers for this purpose. These not only protect the milk from rapid rise in temperature in hot weather but also from meddling cats, dogs, or other animals.

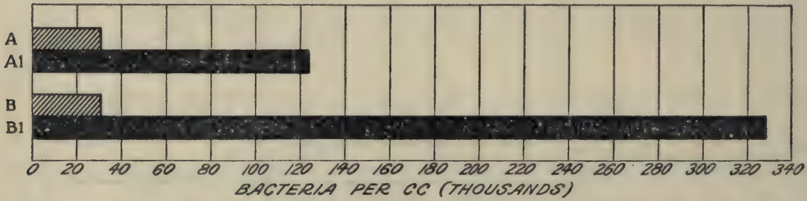

FIGURE 3.—A and B represent identical samples of high-quality raw milk of low bacterial count (31,000 bacteria per cubic centimeter of milk). A' shows the number of bacteria (124,000 per cubic centimeter of milk) in sample A after it was refrigerated for 24 hours at 50° F. B' represents the number of bacteria (328,000 per cubic centimeter) in sample B after it was left standing for 1½ hours at a room temperature of 75° and then refrigerated for 24 hours at 50°. The bacteria increased 4 times in the first sample, and more than 10½ times in the second.

3. Keep milk in the refrigerator as continuously as possible until it is used. Form the habit of putting milk, cream, and butter away first when clearing up after a meal. When using milk in cooking, put the milk container away as soon as the required quantity is measured. More bacteria may develop while milk stands in a hot kitchen for an hour and a half than would develop in the same milk in a cold refrigerator for 24 hours (fig. 3).

4. Keep milk closely covered to exclude not only dirt, bacteria, and particles of spilled food, but also flavors and odors which dairy products readily absorb. Further protect dairy products from absorbing flavors by placing them in the section of the refrigerator where newly chilled air reaches them first. Such odorful foods as onions, cabbage, and fish should be placed where the warmer air is traveling up towards the ice or cooling unit.

5. Never mix new milk with old except for immediate use, because the old milk is likely to contain more bacteria than the new supply. Never pour back into a partly filled container milk that has been out in the air and in another container. Small covered jars and half-pint bottles are convenient for storing small quantities of cream or milk left over from a meal.

6. Clean the top of the milk or cream bottle before removing the pasteboard cap, unless the cap is the kind that fits well down around the mouth of the bottle. Such a cap protects the rim of the bottle from dust, bacteria, and other contamination. If the flat disk cap is used, washing is essential.

7. Wash milk bottles as soon as they are emptied, by rinsing first with lukewarm water and then with hot water. If there is an infectious disease in the house, do not return any bottles except with the knowledge of the health department and under conditions which it may prescribe.

8. Return empty bottles promptly, and do not use them for anything except milk.

DIRECTIONS FOR HEATING

Heating milk in the home to destroy bacteria is not often necessary, now that high-quality milk is available to every community in some form—fresh, canned, or dried—though there are circumstances when heating is still advised. Some doctors recommend boiling any milk that is to be used in infant feeding. If milk of uncertain purity must be used for any purpose or if adequate refrigeration is not available, the day's milk should be heated as soon as possible after it is received. It should then be cooled quickly and stored under the best possible refrigerating conditions, ideally at 45° F.

THREE-MINUTE BOILING

Recent practice seems to favor a short boiling. Put the milk into a kettle large enough to allow for occasional stirring, place it directly over the fire, bring it to the boiling point, and boil for 3 minutes. Cool immediately and quickly by placing the kettle in cold water and changing the water as it takes up the heat; then put the milk at once into the refrigerator or, if it is to be used for infant feeding, make it up at once according to the formula, and then refrigerate it. The advantages of the boiling method are its simplicity, its effectiveness in destroying many undesirable bacteria, and good effect on the digestibility of the casein (p. 9). Disadvantages of this method sometimes mentioned are the change in flavor, the danger of scorching, a small loss of calcium salts when the proteins coagulate on the pan, and the destruction of vitamin C. Not one of these is serious. The slightly different flavor of boiled milk is not unpleasant. Scorching is very unlikely if the flame is kept low enough to prevent the milk from boiling over. The coagulated material can and should be scraped up and used, and as for vitamin C, even raw milk is not a dependable source of this vitamin.

DOUBLE-BOILER HEATING

Double-boiler heating, incorrectly called "slow boiling," is recommended also, and is another good home method of reducing the number of bacteria in milk. For it, use a double boiler that has twice the capacity of the quantity of milk to be heated; for example, a quart size for a pint of milk, or a gallon size for 2 quarts. Put the cold milk into the top of the double boiler, and put cold water into the lower compartment. Have the water touch the bottom of the upper kettle so that the milk will begin to heat up as soon as the water does. Keep the double boiler over a slow flame until the water in the bottom part has boiled for 8 minutes. Then remove the top kettle which contains the milk; place it in cold water, preferably ice water; cool the milk rapidly by changing the water as it becomes warm; and put it into the refrigerator immediately.

There is less change in the flavor of the milk when the double boiler is used, no danger of scorching, and practically no precipitation of nutritive material. The vitamin C is destroyed and the curd is not so fine as that of boiled milk, though it is usually finer than that of pasteurized milk. So far as destroying bacteria is concerned, the results are less uniform from time to time than when the boiling method is used.

HOME PASTEURIZATION

Pasteurization—heating to a specific temperature and then quickly cooling—is the third method. For this a thermometer is necessary.

Milk for general use is conveniently pasteurized in the bottles in which it is delivered. Remove the cover from one bottle, pour out a little of the milk, punch a hole in the cover, replace it, and insert a thermometer. Then set all bottles of milk on a rack in a pail filled with cold water nearly to the level of the milk, and heat until the thermometer in the milk registers 145° F. Remove the pail from the heat and leave the bottles in the hot water for 30 minutes, reheating if that is necessary to keep the milk at 145° F. After the 30-minute period, replace the hot water gradually with cold until the milk has cooled, preferably using ice in the last water. After cooling, keep the bottles in the coolest place available.

MILK PRODUCTS

The average composition of milk and its various products is shown in table 2, and some of the most important products of milk are then discussed in detail.

TABLE 2.—*Average composition of milk and milk products* [1]

Product	Water	Protein (N×6.37)	Fat	Lactose,[2] etc. (by difference)	Mineral matter (ash)	Fuel value per pound
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Calories*
Whole milk	87.1	3.4	3.9	4.9	0.7	310
Cream:						
Single	72.5	2.9	20.0	4.0	.6	942
Double	54.4	2.2	40.0	3.0	.4	1,727
Skim milk	90.5	3.5	.2	5.0	.8	162
Buttermilk	90.7	3.5	.5	4.6	.7	167
Whey	93.0	1.0	.3	5.1	.6	123
Evaporated milk, unsweetened	73.7	7.0	7.9	9.9	1.5	629
Condensed milk, sweetened	27.0	8.1	8.4	[3] 54.8	1.7	1,484
Dried whole milk	3.5	25.8	26.7	38.0	6.0	2,248
Dried skim milk	3.5	35.6	1.0	52.0	7.9	1,630
Butter	15.5	.6	81.0	.4	2.5	3,325
Cheese:						
American cheddar	34.5	25.6	34.7	1.9	3.3	1,916
Swiss	34.0	28.6	31.3	1.9	4.2	1,831
Cottage (skim milk)	74.0	19.2	.8	4.3	1.7	459
Cream	42.7	14.5	39.9	1.0	1.9	1,910

[1] Compiled by Food Composition Section, Bureau of Home Economics.

[2] Including lactic acid and other undetermined substances. The amount of sugar in some of the cheeses is probably negligible.

[3] Mainly added sucrose. Average percentage of added sugar is about 42 percent of the condensed milk

CREAM AND BUTTER

Cream contains the same constituents as milk, but in very different proportions. Cream of course is much richer in fat than milk, the exact degree depending upon both the method and the extent of separation. The fat content averages about 20 percent in thin or " coffee " cream and about 40 percent in thick or " whipping " cream. Since the vitamin A and vitamin D of milk are associated with the fat, thick cream is a much more concentrated source of these vitamins than is thin cream, while thin cream is in turn a better source than whole milk.

The heat necessary in pasteurizing cream causes it to lose some of its body and sometimes to separate slightly; therefore many dairies now homogenize their cream after pasteurizing. This mechanical process makes the fat globules so fine that they show no tendency to rise to the surface. This is an advantage, except in cream for whipping. For this purpose raw cream, which is neither pasteurized nor homogenized, is best. The effect of these processes as well as of other conditions on the whipping quality of cream is discussed in United States Department of Agriculture Bulletin 1075, The Whipping Quality of Cream.

Butter averaging over 80 percent fat is milk fat in a very concentrated form. Among milk products it is the best source of the fat-soluble vitamins A and D, and among foods in general, butter is an outstanding source of vitamin A. In fact, butter supplies a large proportion of the vitamin A requirement of many persons, because it is used on the table and in cooking.

The flavor and texture of butter influence price to some extent, but have very little effect on nutritive value or digestibility. These qualities are an index of care and cleanliness in making and handling butter.

The high fuel value of butter and cream and the many ways in which they can be used in food preparation make them valuable to the person who wishes to gain weight. Though butter and cream are often added to a soup, sauce, or dessert chiefly to improve flavor and texture, these fat-rich foods increase the calories and the vitamin content of the dish at the same time. They are usually considered the most easily digested of the common fat foods, but, like any other concentrated fat, heavy cream and butter may cause disturbance if eaten in overlarge quantities.

SKIM MILK

Skim or separated milk contains a large proportion of the proteins, sugar, minerals, and vitamins B and G of the milk. In both its fresh and dried form skim milk is of great value in preventing pellagra. So much of the fat of the whole milk has been removed that skim milk is lower in fuel value, less rich in flavor, and a very poor source of vitamin A as compared with whole milk. An ounce and a half of butter along with a quart of skim milk provides the equivalent food value of a quart of whole milk.

Skim milk has long been an important feature of the diet of many farm families. In the low-cost diet of farm as well as of urban families skim milk is especially valuable because it provides protein, calcium, and vitamin G abundantly and cheaply. Whenever price prohibits the use of adequate quantities of whole milk for adults or children, at least part of the milk supply may well be used in the form of the skimmed product, if care is taken to furnish other sources of the fat-soluble vitamins A and D. An abundance of skim milk in the child's diet when no whole milk can be provided is a valuable aid to growth.

In diets to reduce body weight or to prevent rapid gain of weight in adults, skim milk is important in filling the constant need for calcium. In this particular type of diet that must be low in fuel value, skim milk is more suitable than whole if its deficiency in vitamin A is made good.

CHEESE

Cheese represents most of the solids of the milk from which it is made, with the exception of the lactose or milk sugar. A large proportion of the lactose, some of the protein, and a part of the vitamin and mineral content remain in the whey or liquid residue from cheese making. Because of its concentration, cheese is very high in nutritive value. Cottage cheese, made from skim milk, is an excellent and inexpensive source of protein, of vitamins B and G, and of calcium and other minerals. The soft domestic package cheeses, such as Neufchâtel and cream cheese, are richer in fat and higher in fuel value than cottage cheese. Neufchâtel is usually made of whole milk; soft cream cheese is made of cream or of extra-rich milk containing at least 6 percent of fat.

The hard, cured cheeses such as American cheddar and domestic swiss are usually made of whole milk, or of milk standardized to a definite fat content. If not made of whole milk, cheddar cheese is described as " part skim " or " skim ", and is correspondingly lower in fuel and vitamin values, as well as in cost.

The flavor of cheese depends somewhat upon the proportion of fat in the milk used, partly on the type of milk—sweet, soured or buttermilk—but more largely on the method and degree of curing and the kind of organisms which cause the curing. Detailed information about various kinds of cheese, their uses in the diet, and home methods of making domestic types, is found in Farmers' Bulletins 960, Neufchâtel and Cream Cheese: Farm Manufacture and Use; 1191, Making American Cheese on the Farm; 1451, Making and Using Cottage Cheese in the Home; and Department Bulletin 608, Varieties of Cheese: Descriptions and Analyses (revised 1932).

CONCENTRATED FORMS OF MILK

Milk may be greatly decreased in bulk and improved in keeping quality and convenience of storage and shipment if a large proportion of the water in it is driven off. The milk is reduced to the thick creamy consistency of condensed and evaporated milks, or to the powdered and flaked forms of the dried-milk products.

The terms " condensed " and " evaporated " as used in the trade refer to somewhat different products. " Condensed milk " is not only reduced in water content, but also has sugar added to assist in its preservation. " Evaporated milk " is simply reduced in water content and then canned without added sugar.

The market offers several dried-milk products, but dried whole milk, dried skim milk, and dried partly skimmed milk are the kinds most commonly used in the home at present. They differ somewhat in food value, flavor, and keeping qualities because of the difference in the quantity of fat each contains. Some dried-milk products are irradiated, and are therefore enriched in vitamin D.

The low cost and the convenience in carrying and storing canned milk and dried milk have encouraged their use in camp, tourist, and home cookery, and in infant feeding. These concentrated forms are especially valuable when travel or any emergency makes it necessary to change the milk supply of the infant or young child.

CONDENSED MILK

In preparation of condensed (sweetened) milk, about 18 pounds of sugar are used for every 100 pounds of pure fresh cow's milk, and the mixture is evaporated in a vacuum at a temperature similar to that of pasteurization. One pound of condensed milk represents about 2¼ to 2½ pounds of fresh milk. The final product is much thicker than unsweetened evaporated milk, because of the sugar added. Condensed milk may be diluted and used in some of the same ways as fresh milk, but it is so sweet that it should not be used for infant feeding unless a physician recommends it.

EVAPORATED MILK

Evaporated (unsweetened) milk is pure, fresh, cow's milk with much of its water removed by evaporation in vacuum pans. About half of the total weight of the fresh milk is evaporated. When the milk reaches this concentration, it is put through a homogenizer to break the fat globules into a much smaller size. The milk is then run into cans, sealed, and sterilized under steam pressure at a temperature well above that of boiling water. An unopened can of evaporated milk will keep indefinitely, but once opened it must be handled and kept cool like any other milk.

One pound of evaporated milk represents on the average 2 pounds of fresh whole milk. Seventeen ounces of evaporated milk contains about the same quantity of solids as a quart of whole milk. Evaporated milk diluted with an equal measure of water may be used in most of the same ways as fresh milk. Where it is lower in price than market milk, it takes an important place in the low-cost diet.

The high temperature of canning changes the flavor of the milk somewhat, giving it a cooked though not unpleasant taste. It affects the casein and makes it more easily digested. The casein of evaporated milk is coagulated in the stomach in a fine, flocculent, tender curd, very easily managed by the delicate digestive systems of invalids and of babies. The curd formed by evaporated milk is very similar to that of mother's milk. Other advantages of evaporated milk in infant feeding are its fine fat globules, and the fact that it is bacteria-free when the can is opened.

Because it has been heated, evaporated milk has a somewhat lower vitamin content than the fresh milk from which it is made. It is a good source of vitamins A and G, but like other milk it needs to be supplemented by foods rich in vitamins B, C, and D.

DRIED MILK

The four principal methods used in the manufacture of dried milks are the spray, roller, vacuum-drum, and Campbell-flake processes. The products resulting from these four processes differ considerably in texture and in the measure or volume of a given weight.

One hundred pounds of fresh whole milk can be reduced to about 13 pounds of fine white powder containing all of the protein, fat, sugar, and minerals, and practically all of the vitamin content of the original milk except vitamin C. Dried whole milk is now distributed in sealed containers to prevent the fat from becoming rancid. After the seal is broken, the milk should be tightly covered again and stored in a cool place to delay changes that impart a rancid flavor. Under the Federal Food and Drugs Act, dried whole milk must contain not less than 26 percent of milk fat and not more than 5 percent of water. It has about 35 percent higher fuel value than dried skim milk.

One pound of dried whole milk (about 4½ cups if made by the spray process) furnishes approximately the same quantity of milk solids as 3½ quarts of fresh whole milk. Four and one half ounces of dried whole milk when mixed with 3½ cups of water makes approximately a quart of fluid milk, equal in solids to a quart of fresh whole milk. Dried whole milk may be used where high-quality market milk is not abundant or where refrigeration facilities are poor. It may replace or supplement fresh whole milk in food preparation (p. 24). High-quality dried whole milk when properly reconstituted with water tastes and looks so much like pasteurized market milk that it is equally pleasing to drink.

Dried skim milk, because it contains practically none of the fat of whole milk, has the best keeping qualities and the lowest price of any type of dried milk. Though it is much lower in fuel value than dried whole milk and has practically no vitamin A and D content, it is very valuable for its building materials. Dried skim milk makes all of the same contributions to nutrition as fresh skim milk except vitamin C. It provides the protein, minerals, lactose, and vitamins B and G of milk at very low cost.

Dried skim milk is cheapest when bought by the barrel. It is available at wholesale rate also in 25- and 50-pound containers. Such an amount can often be purchased jointly by several families and divided among them. Local bakers and ice-cream manufacturers are sometimes willing to sell small quantities of dried skim milk from their supply. Some manufacturers of dried skim milk put up 1- and 5-pound packages which retail at a price per pound considerably above the wholesale price.

One pound of dried skim milk (about 4 cups spray process) furnishes the same quantity of milk-solids-not-fat that is furnished by about 4¾ quarts of fresh skim milk. Three and one half ounces of dried skim milk made into a liquid with 3¾ cups of water equals about a quart of fresh skim milk in solids and in measure.

Dried skim milk reconstituted to fluid form can be used in any dish that calls for fresh skim milk (p. 24). It is especially valuable when used in conjunction with fresh fluid milk to increase the nutritive content of bread and other baked products, vegetable dishes, soups, and desserts. Dried skim milk may be added to the fresh whole milk that children drink, to increase the percentage of milk-solids-not-fat in the growing child's diet. As much as 1 to 1½ ounces of dried skim milk (about one fourth to three eighths of a cup) may be added to 1 quart of fresh milk without appreciable change in the flavor or consistency of the fresh milk. Such an addition makes a significant increase in the food value of the milk.

Dried skim milk has improved the diet in thousands of homes and in many institutions where only a limited amount of money could be spent for food. It has been used with remarkable success in the prevention and cure of pellagra. The concentrated nutritive value of dried skim milk, along with the ease of shipping and storing and its low price in wholesale lots, make it extremely valuable to welfare and relief organizations feeding large groups in times of emergency.

The various kinds of dried milks have many qualities to recommend them for infant feeding. Each of them—whole, skimmed, partly skimmed, and modified—is a sanitary product of fairly uniform composition. When properly prepared and used immediately, reconstituted dried milk is very low in bacterial count. Its flavor is pleasing and not very different from that of fresh milk. It is easily digested, a quality which is always an asset in infant feeding. The quantity to use in making up the formula for an infant depends upon the kind of dried milk selected, and the age of the child, and should usually be determined by a physician. For infants, it is especially important to supplement the vitamin content of the dried milk with other foods.

FERMENTED MILK[3]

In this country buttermilk has been for years the most widely used kind of fermented milk, though acidophilus milk is now well known and even the kefir, kumiss, and yogurt of central Asia and Turkey are familiar here. The characteristic flavor of any fermented milk is due to the kinds of bacteria that bring about the fermentation. All fermented milks contain large numbers of lactic-acid bacteria and most of them contain other desirable bacteria as well as yeast plants. The beneficial effect of these fermented-milk products is due in part to their ability to help overcome excessive putrefaction in the intestinal tract, and in part to the fine, tender, easily digested curd which they form in the stomach. Though their value may be overemphasized by some enthusiasts, these products are beneficial to many babies and to adults with digestive disturbances. Lactose, because it encourages the growth of lactic-acid bacteria, is usually recommended to a person on a fermented-milk diet.

Buttermilk is, accurately speaking, that portion of milk or cream remaining in the churn after the butter is removed. If cream is churned when sweet, the buttermilk is not very different from ordinary skim milk, but as a rule cream is churned when sour, and the buttermilk is slightly acid and has a coagulated curd broken up into very fine particles. Buttermilk is widely used on farms where it is a by-product of buttermaking.

Many city dairies handle buttermilk. In addition to true buttermilk, a large quantity of " cultivated " buttermilk is now manufactured by dairies. Cultured buttermilk is made by first ripening raw or pasteurized milk (skimmed, partly skimmed, or whole) with lactic-acid bacteria cultures, and then stirring the curd until it breaks up into fine particles, just as during churning.

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[3] See Department Bulletin 319, Fermented Milks, for fuller discussion of these products.

Buttermilk is similar to skim milk in food value. It contains most of the protein but very little of the fat of whole milk. Much of the lactose, or the lactic acid that has been developed from it, remains in the buttermilk. Buttermilk, like skim and whole milk, is a fair source of vitamin B and an excellent source of vitamin G, which places it high in the list of pellagra-preventing foods. The food value of cultured buttermilk depends upon the composition of the milk from which it is made. If skim milk is used with the cultures, the food value of the resulting buttermilk is like that of true buttermilk just described. If either whole or partly skimmed milk is used, the fat and vitamin A content are correspondingly higher.

Though buttermilk is most often served as a beverage, either plain or as buttermilk lemonade (p. 27), it may be used in practically the same way as sour milk in cookery, and can also be made into a frozen product.

MILK IN FOOD PREPARATION

Milk used in the preparation of other foods can add materially to the nutritive value of meals. Evaporated milk and dried milk are as valuable as fresh milk for food preparation. Evaporated milk may be used in its full concentration, but diluted with an equal measure of water it is more like fresh milk in food value and consistency. Dried milk, too, may be used in concentrated form or after it is restored to fluid form. In preparing breakfast cereals and quick breads and mixtures using starch, the dried milk may be sifted or mixed in with the dry ingredients, and water substituted for milk in the recipe.

To reconstitute dried skim milk into a fluid, use the proportion of ¼ of a cup of the powder (measure based on spray process) to 1 scant cup of water (a cupful with 1 tablespoonful removed). With the dried whole milk, use ⅓ of a cup of the powder (spray process) to ⅞ of a cup of water (a cupful with 2 tablespoonsful removed). Use either cold or slightly warm water. Boiling water is likely to make the mixture lump. An easy method of mixing is to put the measure of water into a bowl, pour the measure of dried milk on the surface of the water, and beat with a Dover beater or an egg whip. As paste forms on the sides of the bowl, scrape it into the water and continue beating until the fluid is smooth.

Cooking with milk is an easy means of helping adults get their daily milk quota if they dislike to drink it. If a child develops a milk prejudice the problem is not so easily solved because it is more difficult to put the child's full quota of a quart a day into his prepared food. It can be accomplished, however, by cooking his cereal in milk, serving him milk soups and creamed dishes, flavored milk beverages, hot milk toast, and such milk-made desserts as custards, puddings, sherbets, and ice cream. The task is simplified if at least a part of the milk is used in a concentrated form. Adding dried milk to milk-containing dishes, and using fresh milk to dilute evaporated milk are good means of increasing the milk content of a dish without adding to its volume. Using undiluted evaporated milk or a concentrated fluid made of dried milk instead of fresh milk may accomplish the same purpose. However it is done, concealing milk in prepared dishes is a good means of protecting a child's nutrition while he forgets or is helped to overcome his prejudice against milk.

CREAMED DISHES AND GRAVIES

Milk and vegetables served together in creamed dishes supplement each other especially well in food value. Protein foods—meat, poultry, fish, shellfish, and hard-cooked eggs—are often served creamed also. The foundation of creamed dishes is white sauce made of milk, butter, flour, and salt. White sauce is made in varying consistencies according to its intended use, as table 3 shows:

TABLE 3.—*Proportions for ingredients of white sauce*

Consistency	Milk	Flour	Butter or other fat	Use of sauce
	Cup	*Tablespoon*	*Tablespoon*	
Thin	1	1	1	Heavy milk soups.
Thin-medium	1	1½	1½	Creamed dishes of starchy vegetables or of cereals; also gravy.
Medium	1	2	2	Creamed dishes of succulent vegetables, hard-cooked eggs diced meat, and fish; also gravy.
Thick	1	3	2–3	Binder for croquettes, meat loaf, and souffles.

The ingredients for white sauce may be combined in any of several ways. Choice of method depends upon the quantity of sauce to be made and upon the proportion of fat to flour. When equal quantities of fat and flour are used and not more than a pint of sauce is being made, the following method is economical of time and utensils and yields a smooth sauce: Soften the fat or melt it at a very low temperature, blend thoroughly with the flour, add the milk, and heat slowly, stirring constantly until the mixture thickens, and boil until the starch is cooked. In making more than a pint of sauce, use the same method of blending fat and flour, but add hot milk and finish the cooking in a double boiler to save time and the energy required for stirring. For a very large quantity of sauce mix the flour into a thin paste with cold milk, combine this paste with the rest of the milk which has been heated, stir while cooking, and beat in the fat at the last.

Some vegetables such as cabbage, spinach, carrots, and asparagus are delicious and retain more food value and attractive flavor and color if they are cut in small pieces or shredded, cooked for a few minutes in whole or in top milk, and then seasoned and thickened. Recipes for such dishes sometimes describe them as "quick-creamed vegetables" or "5-minute cabbage."

Grated cheese may be added to the white sauce of some creamed dishes to give them a richer flavor and greater food value. A rich cheese sauce of this kind poured over crisp toast makes a very pleasing and satisfying luncheon or supper dish, especially if served with a succulent vegetable, cooked or in a salad.

Milk gravies are made in the same way as white sauce, except that drippings from meat are used as the fat. The consistency of gravy is a matter of individual preference, and varies from that of thin-medium to medium white sauce. (See table 3.)

SOUPS

Milk soups offer an attractive and nutritious way of combining milk with other foods in the main dish for luncheon or supper. Vegetables often used in milk soups are onions, corn, asparagus, cabbage, cauliflower, peas, potatoes, turnips, beans, tomatoes, celery, and spinach, either alone or in pleasing combinations. Peanut butter, salmon or other fish, or grated cheese may be used as the main flavoring material in place of the vegetables.

Milk soups are as thin as or thinner than thin white sauce. (See table 3.) The proportion of flour to use varies from ½ to 1 tablespoon for each cup of liquid. For the liquid, use either all milk or, in the case of vegetable soups, a combination of milk and the juice and the mashed or strained pulp of the vegetables.

For the sake of variety, to conserve food value and flavor, and to give the soup more body, especially if it is for children, use the following method: Grate the raw vegetables or chop them fine, cook them in milk until almost done, add the seasoning, fat, and flour, and continue the cooking for about 5 minutes. Or, if preferred, first thicken the milk to the consistency of thin white sauce and then add the raw chopped or grated vegetables and cook for about 10 minutes in a double boiler.

Egg yolk combined with milk vegetable soups just before serving adds to their richness in protein, fat, iron, vitamin A, and vitamin D.

CHOWDERS

Fish and clam and other shellfish chowders are nutritious and appetizing dishes that contain a good deal of milk. Chowders of excellent flavor and consistency may be made from a combination of fresh and evaporated milk.

Other chowders are made by substituting for the fresh fish small portions of left-over cooked or canned fish, salt codfish, or dried beef. The so-called vegetable chowders are made of corn, lima beans, sliced carrots, or other vegetables.

BEVERAGES

Flavored milk beverages afford pleasing variety to children and other persons who take large quantities of milk daily. The flavors appeal to those who do not like to drink plain milk, or who prefer any food prepared in some unusual way.

Chocolate and cocoa are probably the most popular milk beverages the year around because they are good either hot or ice-cold, and they are easily and quickly made at home. In camp or tourist cookery and in low-cost diets they are featured because they may be made not only of fresh whole or skim milk but equally well of milk reconstituted from the dried, evaporated, or condensed products.

Questions are often asked about the suitability of chocolate and cocoa in flavoring milk for young children. Of the two, cocoa is the more suitable because it is less rich in fat. However, both cocoa and chocolate contain theobromine, which acts as a stimulant, and both are undesirable to use in large quantities or frequently in the diet of children. Used occasionally and not too strong, cocoa adds pleasing variety to milk beverages and milk desserts.

Cafe au lait, which is merely hot milk flavored with a little very strong coffee, has greater food value than ordinary coffee and cream, but because of the caffeine it is not a good drink for children.

Milk shakes and eggnogs are nutritious drinks. To make a particularly smooth eggnog, beat hot milk into the egg, add the desired flavoring, and then chill the mixture before serving. The proportion of flavoring to use in all of these milk beverages depends on individual taste. Children and invalids generally prefer them rather delicately flavored. Shaking or beating milk drinks until they are frothy when served adds to their attractiveness.

A mixture of equal quantities of milk and cream—often called "half and half"—and a combination of buttermilk and cream are richer in flavor and in food value than is plain milk. Ice-cold buttermilk lemonade is a refreshing and nutritious drink when made with buttermilk and somewhat more lemon juice and sugar than used in ordinary lemonade. Whey is sometimes flavored with fruit juice, sweetened, and served as a beverage.

BATTERS AND DOUGHS

Milk used in bread improves its flavor, texture, and food value, and helps to make it brown. All forms of milk may be used to good advantage in quick breads: Sweet milk—whole or skim—fresh, canned, or dried; sour milk, buttermilk, and sour cream. Using some form of milk rather than water in baking is an excellent and inexpensive way to reinforce the nutritive value of the low-cost diet.

Milk or cream that has been pasteurized or boiled sours slowly because of the decrease in the number of lactic-acid bacteria. To hasten the souring of such milk or cream, pour it from the bottle into another container to introduce these bacteria from the air, cover, and keep at room temperature.

When baking with sour milk or sour cream, use the smallest amount of baking soda that will neutralize the acid. One half of a level teaspoon of soda for each cup of sour clabbered milk or cream is sufficient. For milk that is just turning sour, half that proportion of soda may be enough.

DESSERTS

The list of puddings and desserts using a large proportion of milk is almost endless, but they all group together in a few main types.

Junket is one of the simplest, made merely of sweet, flavored milk, thickened to a custardlike consistency by means of a rennet preparation. Caramel, maple, almond, and vanilla are good flavorings for junket. Crushed fresh fruits or fruit sirups or crushed peanut brittle or cinnamon and sugar may be served with it for variety. Serving cream over junket adds to its flavor and food value.

Sweet curd, made in the same way as junket except that the thickened milk is broken up and the whey strained off, is a good filling for pies and tarts. To the curd from one quart of milk add 1 tablespoon butter, ¼ cup sugar, 2 egg yolks or 1 whole egg, a few dried currants or chopped raisins, and the desired spice. Fresh curds and whey is still a favorite dish wherever cheesemaking is carried on.

Devonshire clotted cream deserves to be better known in the United States than it is. It has a nutty flavor that combines especially well with fruits and various desserts. To prepare it, slowly heat containers of milk on which the cream has been allowed to rise undisturbed; then cool, and skim off the thick, clotted cream. This process not only develops a characteristic flavor but checks development of bacteria, so that clotted cream keeps better than ordinary cream.

Many nutritious puddings are made by slowly baking sweetened milk with a cereal—such as rice, corn meal, or buttered bread—with raisins or some other dried fruit or a spice for flavoring. To make creamy rice pudding, add 3 tablespoons rice to 1 quart milk, ⅓ cup sugar, ½ teaspoon salt, ½ teaspoon nutmeg or cinnamon, and dried fruit if desired. Bake the mixture slowly until it thickens to a creamy consistency and the rice grains are soft and several times their original size. These puddings are served hot or cold, with or without cream or a sauce. Hot baked Indian pudding served with ice cream is a favorite combination in New England.

Some of the milk puddings most popular with children are thickened mainly with cornstarch or with tapioca, and may be varied by different flavorings or by serving with fruit sauces. Beaten egg adds lightness and food value.

There are also the true custards, consisting of milk thickened only with egg, and either cooked in a double boiler or baked in a slow oven. The proportion of five eggs to a quart of milk gives a soft custard of medium consistency or a firm, though tender, baked custard. Bavarian, Spanish, and other creams are made chiefly of milk or cream flavored in various ways and stiffened with gelatin or with a combination of gelatin and egg.

Milk sherbets, frozen custards, and ice cream are ways of serving milk and cream that most persons find attractive. The food value of these frozen-milk desserts depends, of course, on the proportion of milk or cream to flavoring material, a fact that should not be overlooked when they are served to children.

POINTS TO REMEMBER

Milk is valuable for the nutrition of young and old, sick and well, inactive and hard working.

A generous daily quota of milk is especially necessary during the years of rapid growth.

Milk has no equal among foods as a source of calcium, which is needed by everyone for sound teeth and strong bones.

The proteins of milk are unusually efficient for growth and are valuable throughout life in maintaining tissue in good condition.

Milk is unique among foods because each of the six vitamins now known is found in it in small or large quantities. Milk fat is often used as the principal source of vitamin A in the diet, and skim milk of vitamin G.

In the low-cost diet milk is prominent because it provides high-quality protein, calcium, and vitamins A and G cheaply.

Dried, evaporated, and condensed milk are often used to advantage in place of fresh milk. Skim milk, in either liquid or dried form, is an important food material.

Artificial feeding of infants has lost many of its hazards since clean milk of low bacterial count has come on the market raw, pasteurized, canned, and dried. If soft-curd milk and vitamin-enriched milk become more generally available, infant feeding will be further simplified.

It is the responsibility of the consumer to know what clean milk is, to demand it in every community, and to keep milk in a cold, clean place from the time it is delivered until it is used.

A good refrigerator that holds a low, constant temperature in the milk compartment is a safeguard to health.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No.1706

VARIETIES of DURUM WHEAT

THE DURUM WHEATS are spring varieties with thick, compact heads, long, stiff beards, and large, hard kernels. They are grown almost wholly in the northern Great Plains area, where they are best adapted because of their resistance to rust and drought, which enables them to outyield other spring wheats. The durums are produced chiefly in North Dakota, South Dakota, and Montana. About 5,000,000 acres are grown annually in the United States.

Durum wheat is used largely for making semolina, from which macaroni, spaghetti, and similar products are manufactured. Domestic manufacturers use less than half the annual production. The price of durum wheat often is less than that of similar grades of hard red spring wheat.

Ten varieties of durum wheat are grown commercially in the United States. These differ in their adaptation and yielding ability, resistance to rust and drought, and in the quality of their grain, as well as in their appearance.

Kubanka is the variety best adapted to all the varying conditions in the sections in which durum wheats are produced. It is high yielding, somewhat resistant to rust, of good milling quality, and well suited to making both macaroni and bread.

Mindum is the most productive durum variety in Minnesota and northeastern North Dakota and is somewhat resistant to stem rust. Macaroni made from Mindum has the best color.

Acme and Monad are two similar amber durum varieties that are very resistant to stem rust. Acme is the highest-yielding durum variety in most of South Dakota, and Monad is the best-yielding variety in North Dakota. Macaroni made from these varieties is grayish and is considered by manufacturers to be less salable than that made from Kubanka.

Nodak is a productive and rust-resistant variety in North Dakota and South Dakota, but is not equal to Kubanka for macaroni manufacture.

Pentad is a red-kerneled variety and is the most resistant to stem rust. For this reason it is extensively grown from late seeding. As the macaroni made from Pentad is very gray, the variety is not used by manufacturers. The grain is chiefly exported or mixed with other cereals for feed.

Peliss is the best-yielding durum variety in the higher and drier sections of Montana and Wyoming, where rust does not occur. It is not equal to Kubanka for macaroni manufacture.

This bulletin is a revision of and supersedes Farmers' Bulletin 1304, The Durum Wheats.

Washington, D.C. Issued October 1933

VARIETIES OF DURUM WHEAT[1]

By J. Allen Clark, *senior agronomist, Division of Cereal Crops and Diseases, Bureau of Plant Industry*

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DESCRIPTION

THE DURUM WHEATS are spring varieties with long stiff beards, and most of them have short, thick, compact heads. The heads are flattened across the sides rather than along the faces of the meshes, as in common wheat. Most of the varieties have white (amber) kernels. The grain is used chiefly for the manufacture of a granular flour known as semolina, from which macaroni, spaghetti, and other alimentary pastes are made.

The durum varieties have very hard kernels. Because of their distinctive characters they are classed as a separate division or species (*Triticum durum*) from the common bread wheats (*T. sativum*). Under the official grain standards of the United States they are graded as class II durum wheat. An average of nearly 5,000,000 acres, or about 8 percent of the wheat acreage of the United States, is devoted annually to the production of this class of wheat. Ten varieties are grown commercially.

WHERE GROWN

The durum wheats are grown almost wholly in the northern Great Plains area. They are produced principally in North Dakota, South Dakota, and Montana. A small acreage also is grown in Nebraska, Colorado, Minnesota, and Wyoming. The section where most durum wheats are produced lies just west of the Red River Valley in North

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[1] The information given in this bulletin is based upon (1) varietal experiments conducted by the Division of Cereal Crops and Diseases of the Bureau of Plant Industry, U.S. Department of Agriculture, and State agricultural experiment stations; (2) classification studies of all American wheat varieties; (3) a survey of the wheat varieties of the United States, in cooperation with the Bureau of Agricultural Economics; and (4) personal observation by the writer of the wheat fields in the States where these varieties are grown.

Dakota and comprises an area from 100 to 250 miles wide, extending from the northeastern part of South Dakota into Canada. The distribution of durum wheat in the United States in 1929 is shown in figure 1. This distribution is very different from that in 1909, which is shown in figure 2. It will be noted that during the last 20 years the center of durum-wheat acreage has moved northward and westward.

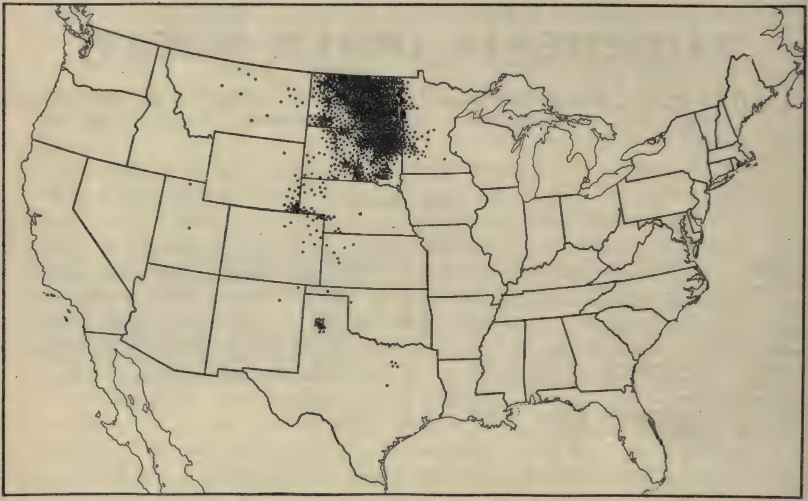

FIGURE 1.—Distribution of durum wheat in 1929. Each dot represents 2,000 acres. Estimated area, 5,842,000 acres.

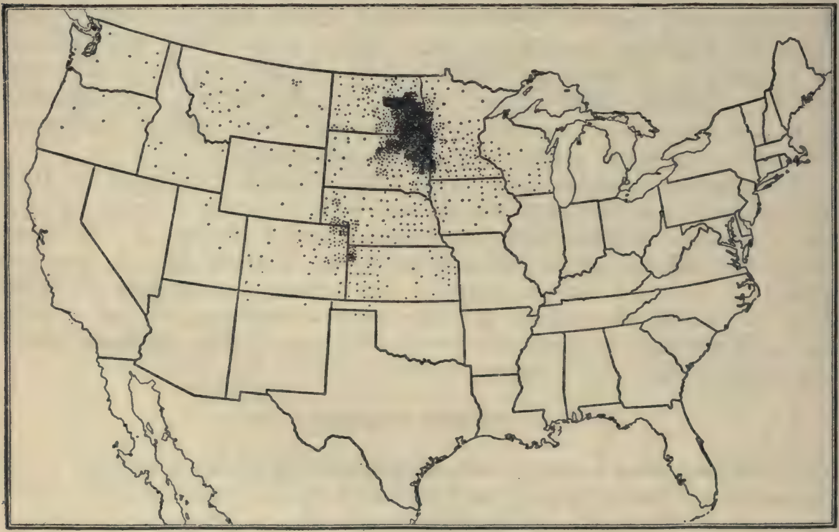

FIGURE 2.—Distribution of durum wheat in 1909. Each dot represents 1,000 acres. Estimated area, 2,503,000 acres.

AREAS TO WHICH ADAPTED

The durum wheats are fairly well adapted to the region between the Rocky Mountains and the Mississippi River where spring wheats are grown. In general, this region includes the Great Plains area and the upper Mississippi Valley. From northern Iowa and Nebraska southward winter wheats are grown more successfully than spring wheats. The durum wheats therefore are not well adapted to this area or to the humid areas of the entire eastern United States. In the Pacific Coast States and in the intermountain districts of the West other classes of wheat consistently outyield the durum varieties. However, in the northern spring-wheat region durum wheats generally outyield the hard red spring wheats. In the subhumid sections of this region, including Minnesota, northeastern South Dakota, and the Red River Valley of North Dakota, durum wheats often develop soft, starchy kernels and therefore are not of satisfactory quality, although they usually outyield the spring common wheats. Were it not for the resistance of durum wheats to stem rust they should not be grown in the subhumid sections.

In the dry, northeastern part of the Great Plains area durum varieties are best adapted and have consistently produced higher yields than have the spring common wheats. Under the semiarid conditions of this section durum wheats usually develop hard, bright, vitreous, amber-colored kernels well suited to the manufacture of semolina and macaroni. Because they are resistant to stem rust and drought and also produce good yields under favorable conditions, the growing of durum wheats in the northern Great Plains steadily increased until 1928. Since that time the production of durum wheat has been restricted because of the increasing acreage of Ceres, a higher yielding hard red spring wheat, and also because of the decreasing export market demands.

USES

Until recent years there usually has been an active foreign demand for durum wheat, but in the early days of its production the development of a domestic market did not keep pace with production. Flour mills were not satisfactorily equipped for grinding durum wheats. Some mills did begin grinding them, however, and gradually large mills have been constructed for grinding durum wheats exclusively. A large trade in semolina and durum flour was developed and a large macaroni industry has finally been established. The annual domestic consumption of durum wheat is now about 32,000,000 bushels, of which an average of 14,000,000 to 15,000,000 bushels have been milled into semolina. Durum wheat that is not exported or used by the macaroni industry is utilized for feed or is blended with other classes of wheat or flour. In the United States very little, if any, flour made from durum wheat alone is used for bread making.

MARKET PRICE

The export demand for durum wheat has usually controlled the market price. When this demand has slackened the price has dropped considerably. Before 1912 the price was always lower than that of hard red spring wheat. About half the time from 1912 to 1919 the price of durum wheat at primary markets was as high as that of similar grades of hard red spring wheat and the price of durum wheat has occasionally been the higher. During the World War, when the price of wheat was fixed, the price of equal grades of durum and hard red spring wheat was the same. Since then the price of durum usually has been somewhat lower than that of hard red spring wheat, depending on the quantity produced.

Because of the greater resistance of durum wheats to rust and drought, which occur frequently in the northern spring-wheat region, they usually have a higher test weight and grade higher in their class than do hard red spring wheats grown under the same conditions.

Low prices for durum wheat tend to decrease its acreage and production. In former years the increased acre yields of durum wheat over those of hard red spring in the northern spring-wheat region have offset a lower price amounting to several cents a bushel. The risk of partial or total loss from rust is still much less with durum than with most common wheats. One of the most important phases of durum-wheat production is the growing of suitable varieties. The durum varieties grown commercially are discussed in this bulletin.

VARIETIES

Ten varieties of durum wheat are grown commercially in the United States. Most of these are distinct and can be identified by plant or kernel characters. Many additional varieties have been grown experimentally, but have not been distributed to farmers and therefore are not discussed in this bulletin.

Varieties of durum wheat differ widely in their adaptation and yielding ability, their resistance to rust and drought, and the quality of their grain, as well as in their external structure and appearance. A few varieties that are similar in appearance differ in origin and adaptation. For convenience in discussion, the varieties are divided into five groups on the basis of chaff, beard, and kernel characters.

Group 1.—Chaff smooth, yellow; beards yellow; kernels white (amber), midsized to large: Kubanka, Mindum, Arnautka, Acme, Monad, Nodak.

Group 2.—Chaff smooth, white; beards white; kernels red, midsized: Pentad (D-5).

Group 3.—Chaff smooth, white; beards black; kernels white (amber), very large: Peliss.

Group 4.—Chaff velvety, black; beards black; kernels white (amber), large: Kahla.

Group 5.—Chaff velvety, black; beards black; kernels red, large: Barnatka.

GROUP 1.—CHAFF SMOOTH, YELLOW; BEARDS YELLOW; KERNELS WHITE (AMBER), MIDSIZED TO LARGE

The varieties included in group 1, although somewhat similar in appearance, show quite different adaptations. Most of the durum varieties grown in the United States are in group 1, the most important being Kubanka.

KUBANKA

Kubanka has smooth yellowish chaff, yellowish beards, and large white (amber) kernels (fig. 3, A). The heads are thick and compact

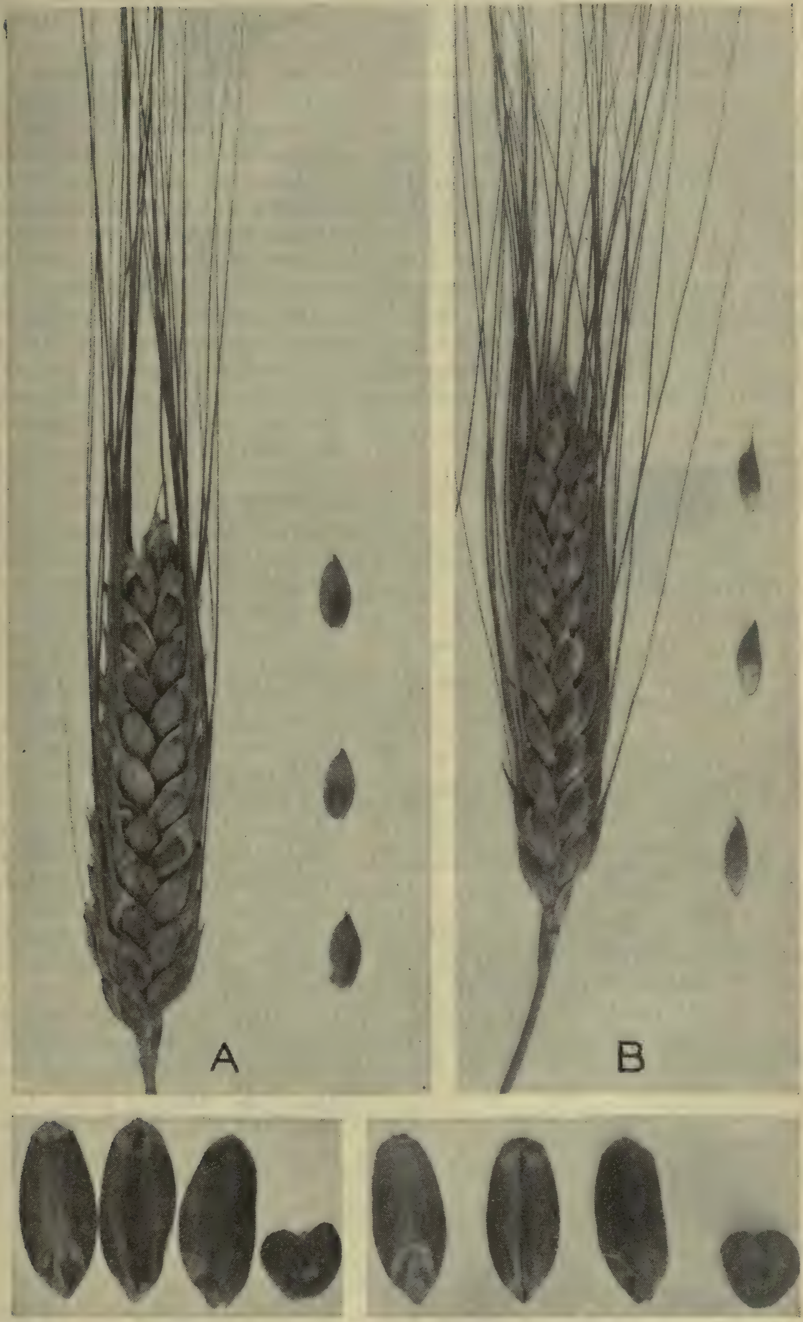

FIGURE 3.—Heads, chaff, and kernels of (A) Kubanka and (B) Mindum. Heads and chaff, natural size; kernels, three times natural size.

and nod slightly at maturity. This variety has shown fair resistance to stem rust under field conditions. Several pure-line strains of Kubanka, very resistant to stem rust, have recently been selected.

Kubanka was introduced into the United States from Russia by the Department of Agriculture, several different lots having been obtained. The principal introduction (F.P.I. no. 5639; C.I. no. 1440) was made in 1900 by M. A. Carleton, cerealist of the Department, from the Uralsk Government in Russia. The seed was increased and distributed by the Department of Agriculture and the North Dakota and South Dakota Agricultural Experiment Stations. Several lots of durum wheat identical with Kubanka were introduced under other names, but they have not become commercially established. They were known as Beloturka, Gharnovka, Pererodka, Taganrog, and Yellow Gharnovka. Kubanka, as originally introduced, was not pure. This has made improvement by pure-line selection possible. A small percentage of red kernels was found in the original shipment and red kernels still persist in the variety.

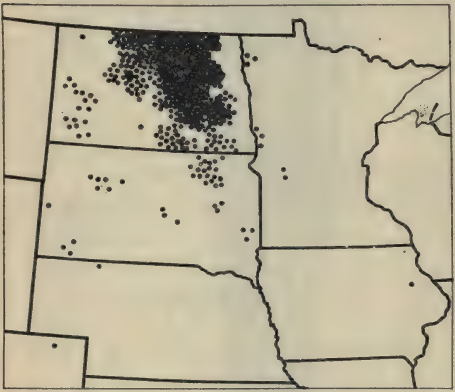

FIGURE 4.—Distribution of Kubanka wheat in 1929. Each dot represents 1,000 acres. Estimated area, 725,000 acres.

Kubanka is grown chiefly in North Dakota, South Dakota, and in several other States (fig. 4). A considerable portion of the durum-wheat acreage consists of unidentified varieties including Kubanka. Just what proportion of this is Kubanka is not known, but it probably is sufficient to make this the leading variety in total acreage.

Kubanka is more widely adapted than any other variety. In experiments in the northern Great Plains it has for years produced consistently high yields. In the higher and drier western sections of the Great Plains area, including eastern Montana, Wyoming, and Colorado, it has been outyielded by the Peliss variety.

In the subhumid section east of the Great Plains area Mindum has produced higher average yields than Kubanka. Where stem rust is an important factor Kubanka has been outyielded by the more rust-resistant varieties, Acme, Monad, Nodak, and Pentad.

Although usually resistant to stem rust under field conditions, Kubanka is sometimes badly injured by rust. It is more resistant to rust, however, than Mindum, Arnautka, Peliss, and Kahla. For the manufacture of semolina and macaroni Kubanka equals or excels other durum varieties grown in the United States, with the exception of Mindum.

MINDUM

Mindum resembles Kubanka in general appearance. It differs, however, in being taller and in having a much shorter brush (tuft of hairs) on the tip of the kernels. The beards of Mindum (fig. 3,

B) are slightly longer than those of Kubanka, and Mindum differs slightly in a few other characters. Being a pure-line selection, Mindum as grown commercially is freer from mixtures than is Kubanka.

Mindum was first found as a mixture in a field of common wheat at the Minnesota Agricultural Experiment Station in 1896. After selection and testing it was distributed to Minnesota farmers in 1917. Mindum is now grown in Minnesota, chiefly in the Red River Valley, and in North Dakota. More than 300,000 acres were grown in 1929 (fig. 5). The largest acreage is in northern North Dakota, and its production is rapidly increasing in Manitoba, Canada.

Mindum has outyielded all other spring-wheat varieties in Minnesota. Although not extremely rust resistant, it is able to produce high yields in spite of the rust. Mindum should replace other durum varieties now grown in Minnesota. For the manufacture of macaroni it is preferred to all other durum varieties because of the excellent quality of the product.

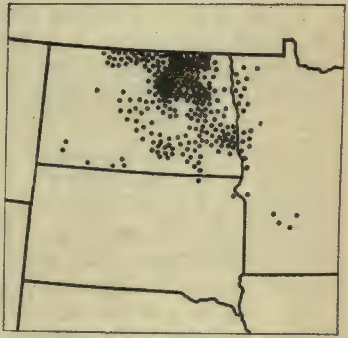

FIGURE 5.—Distribution of Mindum wheat in 1929. Each dot represents 1,000 acres. Estimated area, 322,000 acres.

ARNAUTKA

Arnautka, known also as Goose, Nicaragua, Pierson, and Wild Goose, formerly was one of the most widely grown durum varieties. The known acreage in 1929, however, was less than 18,000 acres. Arnautka differs from Kubanka in being taller and in having longer, more slender, and more nodding heads. The kernels are slightly longer and more slender than those of Kubanka, and the chaff has longer and sharper "beaks" (short beards on the outer chaff). Arnautka is more susceptible to stem rust than Kubanka. It also contains a greater mixture of other types of durum wheat, including red kernels, than does Kubanka.

Arnautka was first imported into the United States by the Department of Agriculture in 1864. However, most of this variety now grown probably was originally brought in by early Russian immigrants. It was grown by them in North Dakota, where it was called Wild Goose. Some of this Arnautka was obtained from T. N. Oium, of Lisbon, N.Dak., distributed by the Department of Agriculture in 1900, and tested with other durum varieties. Since the early nineties Arnautka has been grown in Texas under the name of Nicaragua. It is grown in South Dakota under the name of Pierson.

While Arnautka has been the most widely grown durum wheat in recent years, it is being rapidly replaced by Kubanka, Mindum, and more rust-resistant varieties. However, much of the wheat grown simply as durum or macaroni is Arnautka.

Arnautka formerly appeared to be best adapted to the subhumid and humid sections of the northern spring-wheat region, but during the past few years it has been severely attacked by stem rust in these sections. As a result, it recently has been outyielded by Kubanka in the more humid sections, as well as in the semiarid portion of the northern Great Plains area, where it always has yielded less than Kubanka. The production of this variety, therefore, could be discontinued with profit to the grower.

Arnautka is fully equal to Kubanka in the manufacture of semolina and macaroni.

ACME

Acme has shorter stems, heads, and kernels than Kubanka and is much more resistant to stem rust. The heads also are smaller and not so thick as those of Kubanka.

The kernels are only midsized, pointed at the germ end, and blunt at the brush end, and somewhat boat-shaped. The straw is comparatively weak, so that it lodges easily under humid conditions. The variety is highly resistant to stem rust and has seldom, if ever, been injured by that disease.

Acme was originated from a pure-line selection of Kubanka (C.I. no. 1516) made at the Highmore (S.Dak.) substation by Manley Champlin, formerly of the Department of Agriculture. The selection was made in 1909, and after its high-yielding ability had been determined, seed was distributed from the Highmore substation in 1916 by the South Dakota Agricultural Experiment Station. As the variety differed from Kubanka, it was given the name Acme. Although it was distributed in the spring of 1916, its rust resistance was not known until later that season, when rust appeared in destructive abundance. Its rust resistance and its high-yielding ability caused Acme to become popular.

It now is grown widely in South Dakota and to some extent in North Dakota, Wyoming, and other States. It has outyielded most other durum varieties in nearly all sections of South Dakota and Wyoming. It is best adapted to South Dakota, especially in the sections where rust occurs frequently. More than 70,000 acres of Acme were grown in 1929.

Acme is inferior to Kubanka and Mindum for the manufacture of macaroni and is not desired by the trade because the macaroni made from it is often dull gray instead of bright amber. Therefore, the demand for Acme is limited and its price is lower than that of other amber durum varieties.

MONAD

Monad or D-1 (Durum No. 1) is similar in appearance to Acme. The size, shape, and color of the heads and kernels of the two varieties are almost identical. The varieties are equally resistant to stem rust. Monad also has a comparatively weak straw, but does not lodge so easily as Acme. The two varieties differ slightly in the quality of the grain.

Monad was obtained from the Saratov Government, Russia, in 1903, by H. L. Bolley, of the North Dakota Agricultural College. Several other introductions of wheat were made at the same time, all of which were grown at the North Dakota station from 1904 to 1910. During that period the introductions were selected for disease resistance. Seed of four durum varieties was distributed to farmers and to the Dickinson and Langdon substations by Professor Bolley in 1911. One of these varieties was designated as D-1 (Durum No. 1).

The identity of D-1 on the farms was almost lost. In 1917, after its value had become apparent at the Dickinson substation, D-1 was named Monad. During the rust epidemics of 1915 and 1916 the extreme resistance of this variety was strikingly apparent. Because of this and its high yield, seed of Monad was increased and again distributed by the North Dakota station.

In experiments in North Dakota, Monad generally has outyielded other durum varieties. It has been outyielded in Minnesota by Mindum and in South Dakota by Acme. In general, however, Monad is well adapted in the sections of these States where stem rust has been destructive. Like Acme, Monad is inferior to Kubanka for the manufacture of macaroni, as the product has a dull grayish color, but is a little better than Acme for this use. Because of the color of the macaroni, a lower price is paid for Monad than for any other amber durum variety except Acme.

NODAK

Nodak is very similar to Kubanka but is much more resistant to stem rust. The kernels of Nodak are softer and under humid conditions do not retain the hard, vitreous, amber appearance so well as do the kernels of Kubanka or Mindum.

Nodak was developed in cooperative experiments by the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station at Dickinson, N.Dak. It is the result of a selection made from Kubanka in 1915. Nodak was first distributed for commercial growing in North Dakota in 1923. About 37,000 acres were reported in 1929.

Nodak outyields both Kubanka and Mindum in eastern North Dakota and in South Dakota, where rust usually occurs. Except in sections where rust is most severe, Nodak should not be grown in preference to Kubanka or Mindum, because it often will not grade so well and is less desirable for the manufacture of semolina and macaroni.

GROUP 2.—CHAFF SMOOTH, WHITE; BEARDS WHITE; KERNELS RED, MIDSIZED

Group 2 includes only one variety, namely, Pentad, or D-5, which differs from the other durum wheats in having white instead of yellowish chaff and red instead of white (amber) kernels. Several durum varieties, such as Kubanka and Arnautka, contain slight mixtures of red kernels. Many of these mixtures have been separated and grown and appear to have resulted from field crosses between durum and hard red spring wheats.

PENTAD

Pentad, or D-5 (Durum No. 5), is known also as "D-Fife", Ladd Durum, Red Durum, Resistant Fife, and Rustproof. The heads are more slender and less compact than those of the other durum varieties grown in this country (fig. 6, A). The kernels are short, boat-shaped, pointed at the germ end, blunt at the tip end, and dull red.

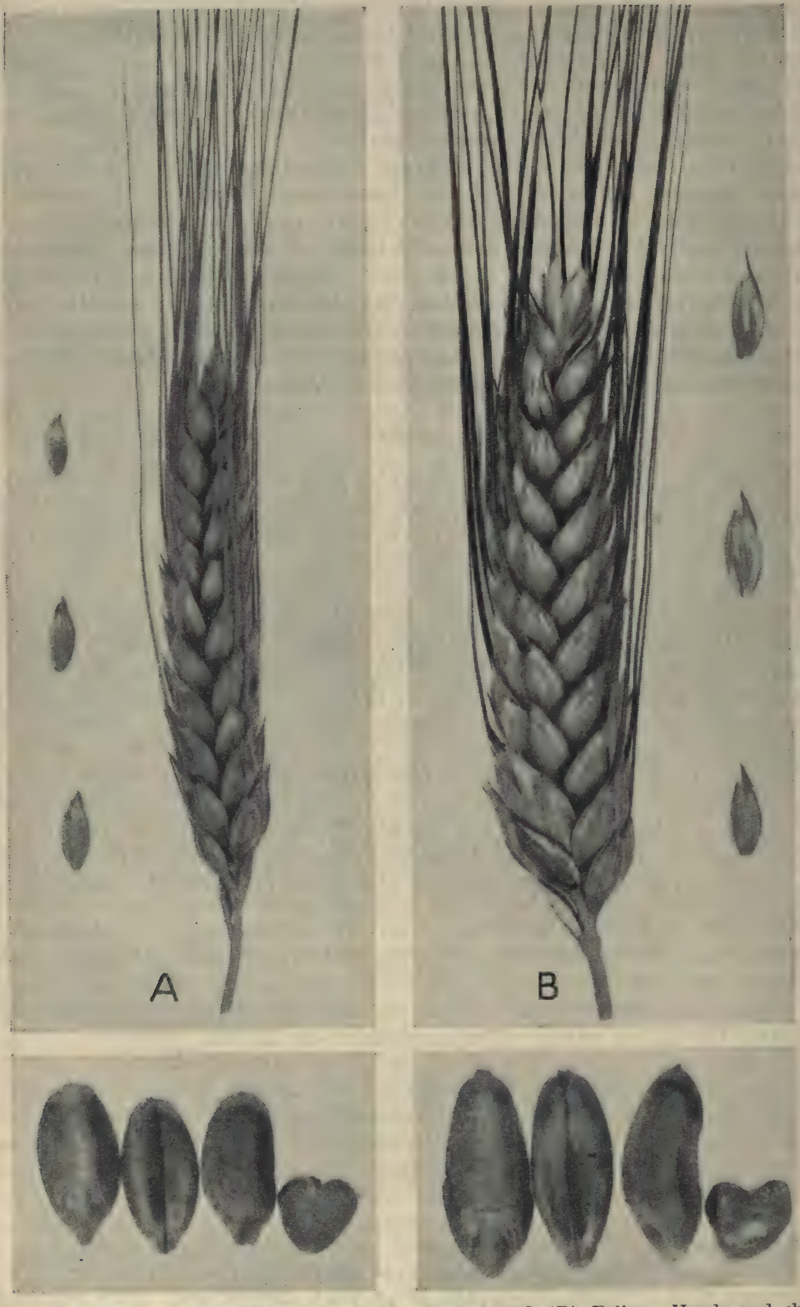

FIGURE 6.—Heads, chaff, and kernels of (A) Pentad and (B) Peliss. Heads and chaff, natural size; kernels, three times natural size.

The plants are of medium height and do not lodge so easily as those of Acme and Monad. Pentad is more resistant to stem rust than any other durum variety.

Pentad was introduced from Russia in 1903 by H. L. Bolley and was first distributed from the North Dakota Agricultural Experiment Station in 1911. It has become rather widely grown, especially in North Dakota, because of its extreme rust resistance. It is also grown in Minnesota, South Dakota, Nebraska, Wyoming, and Colorado. More than 1,000,000 acres of Pentad were reported in 1929. In spite of the relatively low price paid for the grain, the acreage of this variety has increased. When severe epidemics of stem rust occur Pentad frequently outyields all other varieties except, perhaps, Acme and Monad. The two latter are almost as productive as Pentad in seasons when stem rust is very abundant. Pentad, therefore, is best adapted to sections where stem rust is common. Because it is not injured by rust, it produces good yields from late seeding and is usually so grown. However, in these sections, other varieties grown from early seeding, such as Mindum in Minnesota and Kubanka in North Dakota, usually yield more than Pentad from late seeding. The grain of Pentad is not suitable for the manufacture of good quality semolina and macaroni, being less valuable for this purpose than that of Monad or Acme. Most of the grain of this variety is used for feed, particularly poultry feed.

GROUP 3.—CHAFF SMOOTH, WHITE; BEARDS BLACK; KERNELS WHITE (AMBER), VERY LARGE

The only variety in group 3 is Peliss. Another variety, similar to it, and known as Golden Ball, is grown to a very small extent in Canada, but it will not be discussed in this bulletin.

PELISS

Peliss (Pelissier) probably is more commonly known on farms as Black Bearded durum. It is a tall and vigorous variety. The heads are large, thick, and compact (fig. 6, B). The beards are long, stiff, and black, and the chaff is nearly white and similar to that of Pentad. When threshed, it can be distinguished from other durum wheats by the very long, thick, distinctly curved, white (amber) kernels. It is not resistant to stem rust.

Peliss was introduced into this country in 1900 by the United States Department of Agriculture. The original seed was obtained from M. Pelissier in the Province of Oran, Algeria. After thorough testing it was increased and distributed in this country, principally in Montana, by the Department of Agriculture and the Montana Agricultural Experiment Station.

This variety was grown in Montana, North Dakota, and South Dakota in 1929 on about 6,000 acres. It is most important in Montana, where it has outyielded other varieties of durum wheat. It is a high-yielding variety in eastern Colorado and Wyoming. In parts of these sections, however, winter wheat is more profitable than spring wheat. In the Dakotas and Minnesota, where stem rust is prevalent, the altitude lower, and the rainfall greater, it generally is outyielded by other durum varieties. It therefore is not well adapted east of Montana and Wyoming.

Peliss is slightly inferior to Kubanka in the manufacture of semolina and macaroni. The large size of its kernels causes some trouble in the cleaning machinery now used.

GROUP 4.—CHAFF VELVETY, BLACK; BEARDS BLACK; KERNELS WHITE (AMBER), LARGE

The only variety discussed in group 4 is Kahla. Very similar wheats are grown under several different names, but all are so nearly identical that they are considered as one variety.

KAHLA

Kahla, known also as Black Don, Black durum, Blackchaff durum, Black Emmett, Black Swamp, Purple durum, Red Swamp, and Sloat, has velvety or hairy black chaff, black beards, and white (amber) kernels. The short fine hairs occur mostly on the edges of the chaff. The heads are rather slender and nodding. The variety is not resistant to rust.

Kahla was introduced into the United States from Algeria by the Department of Agriculture in 1901. A similar wheat, containing mixtures of red kernels, was received from Russia under the name Black Don in 1900. Other introductions of this same type have been made by the Department and probably by certain individuals. Kahla occasionally is found as a mixture in other durum varieties. Both Kahla and Black Don were distributed for trial when first introduced by the Department but did not prove to be high-yielding varieties. Kahla has been grown commercially in Montana, North Dakota, and South Dakota, and to some extent in other States. It is relatively unimportant except in a few local sections. It was grown on about 28,000 acres in 1929.

The yields of this variety have been decidedly lower than those of Kubanka and several other durum wheats, both in the Great Plains and in subhumid sections. As Kahla is not resistant to rust, it should not be grown in sections where rust occurs. It does best in the western Great Plains area, as it is early and very resistant to drought, but it does not yield so well as other varieties of durum and the leading varieties of hard red spring wheat. In grain quality Kahla is equal or superior to Kubanka in the manufacture of semolina and macaroni.

GROUP 5.—CHAFF VELVETY, BLACK; BEARDS BLACK; KERNELS RED, LARGE

The only variety discussed in group 5 is Barnatka, which is of minor importance in the United States.

BARNATKA

Barnatka differs from Kahla mainly in having red kernels. It was introduced into this country from Russia and distributed for commercial growing by A. L. Hilleman, of Windsor, N.Dak., about 1925. The variety is not pure, and little is known regarding its yield, quality, or rust reaction. Nearly 5,000 acres were reported in 1929.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1707

VARIETIES of COMMON WHITE WHEAT

1862 1889

THE common white wheats include those winter and spring varieties of common wheat that have either soft or hard white kernels. Washington, Idaho, Oregon, Michigan, New York, and California lead in production of these varieties. Nearly 4,000,000 acres are grown annually in the United States, comprising about 6.3 percent of the total wheat acreage.

Most of the common white wheats are soft and are used in making biscuit and pastry flours and breakfast foods or are blended with hard wheats for bread flours. Forty-four varieties are grown commercially in the United States; 28 are spring wheats and 16 are winter wheats.

Goldcoin is the most widely grown white wheat. It is the most important variety in Michigan and New York and is grown extensively in limited areas of the Pacific Northwest. It is a winter variety, shatters easily, and is not adapted to dry, windy areas or to areas where harvest is delayed after the grain is mature.

Baart is the most productive spring wheat in those sections of Washington where the rainfall is less than 15 inches. It is well adapted to Arizona and to the drier sections of California and is suitable for breadmaking.

Federation, although a spring variety, is extensively grown from fall seeding in Umatilla County, Oreg., and in adjacent Washington, where it outyields all other varieties when not injured by winter-killing. It also gives high yields from spring sowing in eastern Oregon and Washington and on the irrigated lands of southern Idaho.

Pacific Bluestem is a productive spring wheat in eastern Washington and northern Idaho where the rainfall exceeds 15 inches, and is well adapted to fall sowing in the Sacramento Valley of California.

Dicklow is extensively grown under irrigation in southern Idaho and in Utah, where it commands a premium from millers because of its white color and desirable quality for biscuit and pastry flours.

Quality is the only white wheat grown to any extent in North Dakota, South Dakota, and Minnesota, because of the limited demand for an early variety. It should be replaced by Reward or other hard red spring varieties.

This bulletin is a revision of and supersedes Farmers' Bulletin 1301, The Common White Wheats.

Washington, D.C. Issued October, 1933

VARIETIES OF COMMON WHITE WHEAT[1]

By J. Allen Clark, *senior agronomist*, and B. B. Bayles, *associate agronomist*,
Division of Cereal Crops and Diseases, Bureau of Plant Industry

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COMMON WHITE WHEATS DEFINED

THE common white wheats include those varieties of common wheat having white kernels. Under the official grain standards of the United States, wheat is graded into five classes, one of which is designated as class V, white wheat. This class includes the white-kerneled varieties of both common and club wheats, but only the common wheats are considered in this bulletin. Although most of the durum varieties also have white kernels, they are designated as a separate class.

The kernels are described as white because they lack the coloring matter or pigment in the seed coat, or bran, which red wheats possess. They are not really white, but pale yellow. They may be hard and translucent (amber) or soft and opaque. Both winter and spring varieties are grown.

More than 3,900,000 acres, or about 6.3 percent of the wheat acreage of the United States, are annually devoted to the production of this class of wheat, of which 44 varieties are grown commercially.

WHERE GROWN

Common white wheats are grown principally in the Pacific coast region. Washington, Idaho, Oregon, and California lead in their production. Michigan, New York, Utah, North Dakota, Montana, and Colorado also produce a large acreage. The section of heaviest production is in eastern Washington and eastern Oregon. The distribution of common white wheats in the United States in 1929 is shown in figure 1. It was estimated that 3,905,083 acres of common white wheat, including Sonora, were grown in that year. While not so extensively grown as most other classes, white wheat is the leading class in Arizona, California, Idaho, Nevada, New York, Oregon, and Washington.

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[1] The information in this bulletin is based upon (1) varietal experiments conducted by the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U.S. Department of Agriculture, in cooperation with State agricultural experiment stations; (2) classification studies of all American wheat varieties; (3) a survey of the wheat varieties of the United States, in cooperation with the Bureau of Agricultural Economics, based upon about 10,000 returns from 74,000 questionnaires sent to crop correspondents; and (4) personal observations for several years by the writers in the wheat fields in the States where these varieties are grown.

In general, the common white wheats are adapted to the districts of heavy production shown in figure 1. In Michigan, New York, and other Eastern States only winter varieties are grown. In Arizona, California, Colorado, Utah, and Nevada nearly all the common white wheats are spring varieties, although they are usually fall sown except in Colorado and Utah, where they are spring sown in irrigated districts. In the other Western States both winter and spring varieties are grown.

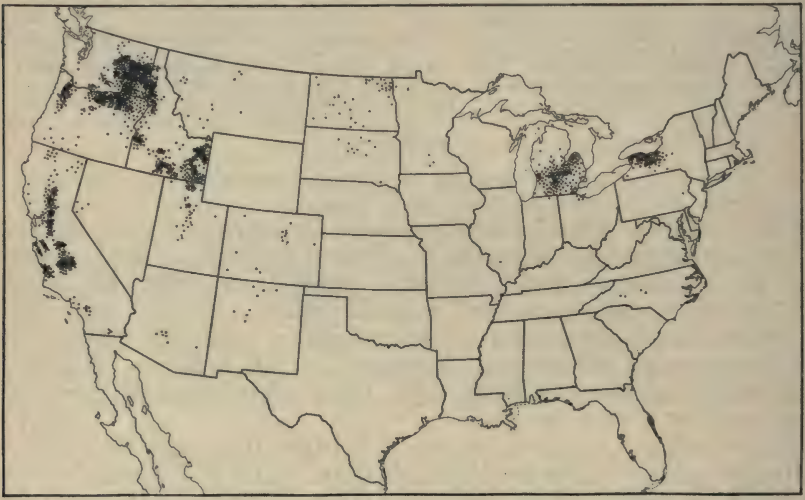

FIGURE 1.—Distribution of common white wheats in the United States in 1929. Each dot represents 2,000 acres. Estimated area, 3,905,000 acres.

Common white wheats produce the highest comparative yields in most of Arizona, California, Nevada, Oregon, southern Idaho, and western Montana. They usually are outyielded by winter varieties of the club wheats in the more humid sections of eastern Washington and northern Idaho and by hard red winter varieties in the drier sections. Certain common white varieties usually are the most productive of the spring wheats in these sections. White wheats generally produce higher yields under irrigation than do hard red spring varieties, and are of considerable importance in the irrigated sections of the Intermountain and Pacific Coast States.

Winter varieties of common white wheat are well adapted in New York, Ohio, and parts of Michigan. However, the soft red winter wheats are more important in Ohio and Michigan because of the larger demand and better price for red wheat in that area. Superior lots of white wheat may, however, in some instances carry substantial premiums. In the eastern half of the United States the red wheats usually outyield the common white varieties.

USES

In general, the common white wheats are inferior to the hard red spring and hard red winter wheats for bread making. However, a few common white varieties have high bread-making value and are ground into bread flour without being blended with other classes. The common white wheats are grown chiefly in irrigated and nonirrigated areas where soil and climatic conditions are unfavorable for the production of wheat having a high protein content.

The common white wheats, if soft and starchy, are well suited to the manufacture of biscuit and pastry flours, crackers, and breakfast foods. Large quantities of common white wheat are utilized for these purposes in both the eastern and western parts of the United States. Except in small local mills, the wheat or flour from soft common white varieties is blended with that from good hard white or hard red spring or hard red winter varieties for manufacturing bread flours. The soft white wheats are extensively exported to western Europe and the Orient. In certain localities there also is a local demand for white wheat for special purposes, such as making whole-wheat products. This demand results in good prices. In the sections where common white wheats are best adapted they usually are more profitable than other classes.

VARIETIES

Approximately 44 distinct varieties of common white wheat, known by about 150 names, are grown commercially in the United States. Of these 44 varieties, 18 were reported grown on less than 5,000 acres each in 1929, and are listed in this bulletin as additional varieties. Of the 44 varieties, 28 are spring wheats and 16 are winter wheats. They differ widely in yield, quality, earliness, and adaptation, as well as in general appearance and behavior. For convenience, the varieties of common white wheat are here arranged into seven groups on the basis of the most easily observed characters of the head, chaff, and plant.

Group 1.—Heads beardless; chaff smooth, white or yellow; winter wheats: **White Winter, Wilhelmina, Eaton, Greeson, Prohibition.**

Group 2.—Heads beardless; chaff smooth, white or yellow; spring wheats: **Pacific Bluestem, Dicklow, Quality, Bunyip, Defiance, White Federation, Rink, Surprise, Onas, Pilcraw.**

Group 3.—Heads beardless; chaff smooth, brown or red; winter wheats: **Goldcoin, Dawson, Honor.**

Group 4.—Heads beardless; chaff smooth, brown or red; spring wheats: **Federation, Hard Federation.**

Group 5.—Heads beardless; chaff velvety, white; winter wheat: **Silvercoin.**

Group 6.—Heads beardless; chaff velvety, brown or red; spring wheats: **Sonora, Galgalos.**

Group 7.—Heads bearded; chaff smooth, white or yellow; spring wheats: **Baart, Propo.**

GROUP 1.—HEADS BEARDLESS; CHAFF SMOOTH, WHITE OR YELLOW; WINTER WHEATS

Five winter varieties are included in this group. The kernels range in size from small to large. The heads of some varieties are long and open, while others have shorter, more compact heads, somewhat clubbed at the tip. The varieties in group 1 can be successfully grown only from fall sowing.

WHITE WINTER

White Winter, known also as Bishop's Pride, Oregon White, and Wold's White Winter, has beardless heads, smooth white chaff, and soft white kernels. The heads are erect, of medium length, compact, and square tipped. The kernels are short and rounded. It is a late-maturing winter wheat and will not produce a crop if sown in the spring. It is not very hardy as a winter wheat.

This is one of the oldest wheats grown in western Oregon, being the principal variety as early as 1855, probably having been introduced from England. It is now grown in the humid sections of western Oregon and western Washington, also in one county in northern California.

White Winter is one of the highest-yielding varieties in the Willamette Valley of Oregon. Because of its late maturity it is adapted only to humid sections having cool summer weather. It can be grown with success in the United States only in the humid areas of the Pacific Northwest. Because the grain is soft and starchy, flour from White Winter is not suitable, under modern commercial bakeshop practice, for making bread of high quality.

WILHELMINA

Wilhelmina wheat, known also as Queen Wilhelmina and Holland, is a late-maturing winter variety adapted only to the humid sections of western Oregon and Washington. It was introduced under the name Queen Wilhelmina from the Netherlands by the Oregon Agricultural Experiment Station about 1914. A few years later it was distributed as Holland in the Willamette Valley of western Oregon where it is now one of the leading varieties. Wilhelmina is recommended for growing in the Willamette Valley and may profitably replace such varieties as Red Russian, Defiance, Hybrid 128, and Eaton.

EATON

Eaton is nearly identical with White Winter, but differs from it in having a slightly clubbed head. It is not known where Eaton originated, but it probably is an old English variety like White Winter. It has been known in the United States at least since 1894. It is now grown as a winter wheat in northwestern Oregon but not in large quantities.

Eaton is about equal to White Winter in yield and quality and is adapted to nearly the same conditions.

GREESON

Greeson, or Greensboro, is very similar to Prohibition, but has slightly longer heads. The kernels are more tapering and not "humped" like those of Prohibition.

Greeson is reported to have been originated by a Mr. Greeson, of Guilford County, N.C. It was distributed a number of years ago and is now grown in three counties in North Carolina. Nothing is known about its yielding ability as compared with that of other varieties except that it has become rather popular in the locality where it was originated.

PROHIBITION

Prohibition, known also as Prohi, is somewhat shorter and earlier than White Winter, and the heads are slightly longer and less erect. The kernels are rather small, soft, and distinctly humped.

Prohibition was named and distributed by B. H. Irvine, of Scio, Oreg., about 1885. The seed had been obtained from the Commissioner of Agriculture at Washington under another name. It was distributed in the vicinity of Scio, in Linn and Marion Counties, Oreg., where it is now grown on the red-hill lands.

Prohibition apparently is adapted to a limited section of the Willamette Valley of Oregon, outside of which it has scarcely been grown or tested. Owing to its lateness it is adapted only to cool, humid sections.

GROUP 2.—HEADS BEARDLESS; CHAFF SMOOTH, WHITE OR YELLOW; SPRING WHEATS

Most of the varieties in group 2 have slender, pointed heads, but a few have compact, square, or club-shaped heads. Although these varieties are true spring wheats, several are grown from fall sowing in areas where the winters are mild.

PACIFIC BLUESTEM

Pacific Bluestem, the Bluestem wheat of the Pacific Coast States, is also known as Australian, Chile, Palouse Bluestem, White Australian, White Bluestem, White Chile, and White Elliott. It has beardless heads with yellowish-white to light-brownish chaff and soft to semihard white kernels. The heads are erect and nearly square, although they taper slightly at the tip (fig. 2, A). The chaff is stiff and wide and not easily broken off. The kernels are of medium size and rather soft but are harder than those of some of the common white varieties. Pacific Bluestem is a true spring wheat, although it is grown from fall sowing in the mild climate of California and Arizona and occasionally in Oregon.

Pacific Bluestem is a very old wheat. It formerly was called White Lammas and was the leading variety in Australia during the early years of wheat production in that country. It was introduced from Australia into California during the early fifties. It is generally known as White Australian in California but is called Bluestem in the Pacific Northwest. Pacific Bluestem was introduced into the Pacific Northwest in 1882, having been grown first in the Walla Walla Valley of Washington. It was for many years the most widely grown variety of common white wheat, but its acreage decreased from 1,363,000 acres in 1919 to about 364,000 acres in 1929. It is grown in all States west of the Rocky Mountains and is of greatest importance in Washington, California, Idaho, and Oregon. Its distribution in 1929 is shown in figure 3.

In the Sacramento Valley of California, Pacific Bluestem usually is sown in the fall or winter and is considered a winter wheat by many growers. Until recently no variety has been able to compete with it in that section. However, since 1918 it has been exceeded in acreage by Baart. It usually is outyielded by Baart and Bunyip in the San Joaquin Valley and by Baart, Defiance, and Sonora on the irrigated lands of southern California and Arizona.

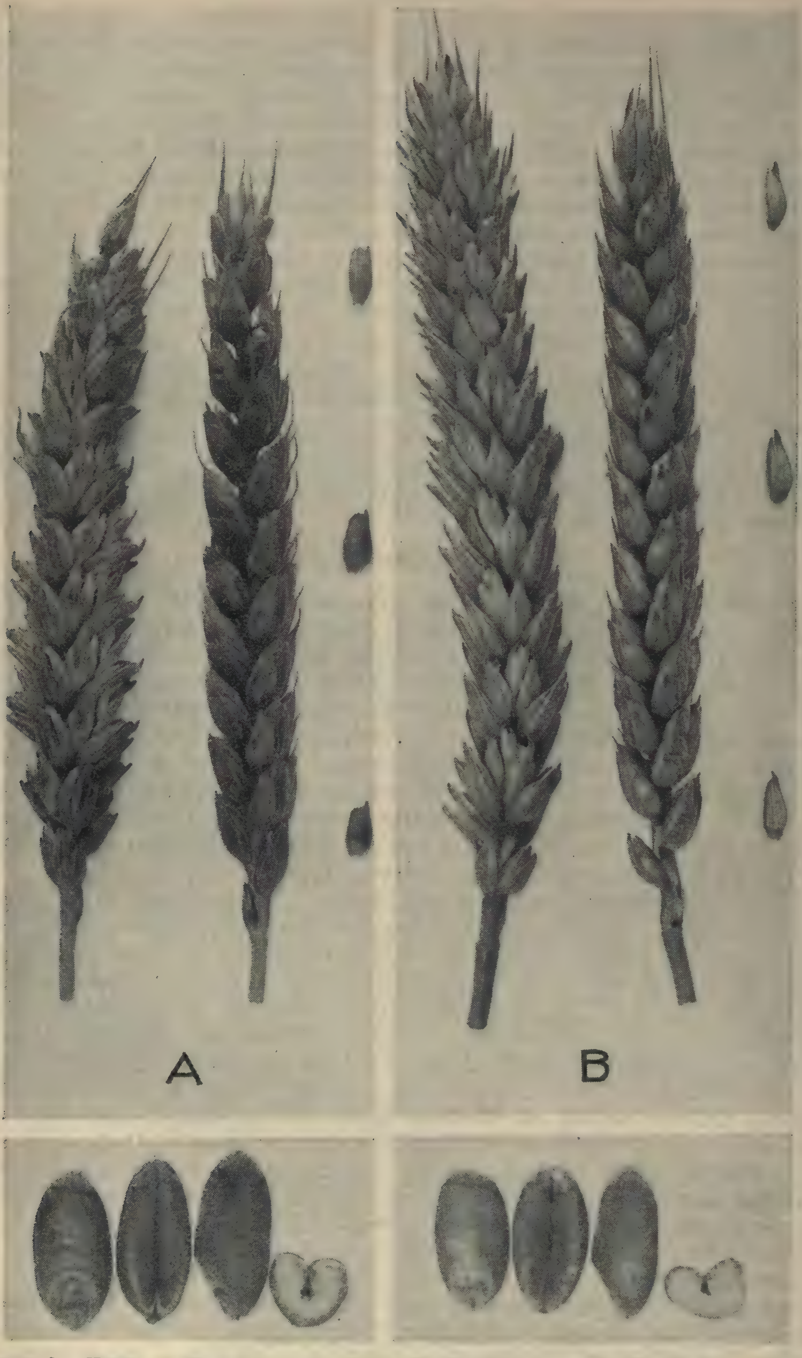

FIGURE 2.—Heads, chaff, and kernels of (A) Pacific Bluestem and (B) Dicklow. Heads and chaff, natural size; kernels, three times natural size.

Pacific Bluestem is still an important variety in Lincoln and Douglas Counties in eastern Washington, but has been largely replaced by Federation in the Palouse district of Washington and Idaho and by Baart in the Big Bend section of central Washington, where the rainfall is less than 15 inches.

Pacific Bluestem is considerably outyielded by Federation and Dicklow in the irrigated sections of Utah and southern Idaho. It was for many years considered the best milling and baking wheat grown in the Pacific Coast States, but since the introduction of hard red winter and hard red spring varieties within the last 30 years it has lost this leading position. It is now considered inferior to Baart.

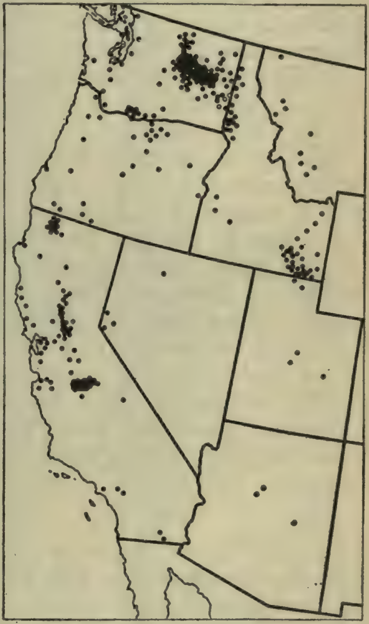

FIGURE 3.—Distribution of Pacific Bluestem wheat in 1929. Each dot represents 1,000 acres. Estimated area, 364,000 acres.

DICKLOW

Dicklow wheat, known also as Dago, Hawley, Holly, Jim Holley, and Richard Low, is almost identical with Surprise, from which it was selected. It is one of the types found in Surprise. Dicklow can be distinguished from Surprise by the heavy white waxy bloom on the stems just before ripening. It is a late-maturing spring wheat. Its heads are quite clubbed at the tip (fig. 2, B). The kernels of Dicklow are soft and somewhat flattened.

Dicklow was selected from a field of Surprise or California Club in Utah County, Utah, by Richard Low. It spread rapidly over northern Utah. In 1912 and 1913 it was distributed in southern Idaho, where it is still one of the most important varieties grown under irrigation.

At present Dicklow is grown chiefly in southern Idaho and Utah, but there are smaller acreages in Washington, Montana, Wyoming, Colorado, Nevada, Oregon, and California. More than 250,000 acres of Dicklow wheat were grown in 1929. The section of heaviest production is in the vicinity of Twin Falls, Idaho.

Dicklow has outyielded all other varieties except Federation on the irrigated lands of southern Idaho and northern Utah. In experiments during the 13 years from 1919 to 1931 Dicklow has been outyielded by Federation and partly replaced by it. These two varieties should be grown to the exclusion of all others on the irrigated lands of southern Idaho and northern Utah. The chief objections to Dicklow are susceptibility to loose smut, tendency of the heads to shatter, and weakness of straw. In Federation the tendency to lodge and shatter has been largely overcome.

Outside of southern Idaho, northern Utah, and the lower Yakima Valley of Washington, Dicklow is not especially promising even under irrigation. Because of its late maturity it is not adapted to the dry-land sections.

Dicklow is very much in demand by the millers of southern Idaho for making biscuit and pastry flour. There it usually commands a premium over Federation because its flour is whiter.

QUALITY

Quality (Burbank's Quality) is an early-maturing spring wheat. The heads are beardless, erect, tapering, of medium length, and have smooth, white chaff (fig. 4, A). The kernels are rather short and hard and shatter from the heads very easily at maturity. Although Quality is a spring wheat, it can be grown from fall sowing in mild climates like that of California.

Quality was first distributed from Santa Rosa, Calif., by Luther Burbank in 1918, although its origin is not known. It is grown now in many other States.

Quality is outyielded by nearly all varieties now grown in the Sacramento Valley of California. It shatters so easily when ripe that it cannot be harvested with the combined harvester without much loss of grain. In North Dakota, South Dakota, Minnesota, and Montana, where Quality is grown as a spring wheat, it is outyielded by Marquis, Ceres, and other varieties of hard red spring wheat. More than 130,000 acres of this variety were grown in 1929. It cannot be successfully grown from fall sowing except in California and Arizona, because it is not a winter wheat and cannot survive ordinary winter temperatures.

Quality wheat has hard kernels, and for making bread the flour from this variety compares favorably with that from hard red spring wheats.

BUNYIP

Bunyip wheat is much earlier maturing and shorter in height than Pacific Bluestem and has a slightly harder kernel. The heads are beardless, or tip awned, broad but tapering, and the chaff is yellowish white with brown stripes (fig. 4, B). The brown stripes give the heads a brown appearance in the field. Bunyip is a spring wheat but is usually grown from fall sowing in California. Although it is early maturing and short, the straw is not very strong, and sometimes lodges.

Bunyip was originated in 1897 by William Farrer, New South Wales, Australia, from a cross between Rymer and Maffra wheats. It was first introduced into the United States by the Department of Agriculture in 1914. A sample was obtained by the Sperry Flour Co., from the Australian exhibit at the Panama-Pacific Exposition of 1915. Bunyip was distributed in California in 1918 by the company mentioned after it had been tested in comparison with a few other Australian varieties. It is now grown extensively in the San Joaquin Valley and to some extent in other sections of California, and has produced good yields. It is a better yielder than Pacific Bluestem on lighter and drier soils and is preferred to Baart by many growers because the heads are beardless. More than 100,000 acres of Bunyip were grown in 1929. Bunyip is superior to both Pacific Bluestem and Baart in milling and bread-making qualities.

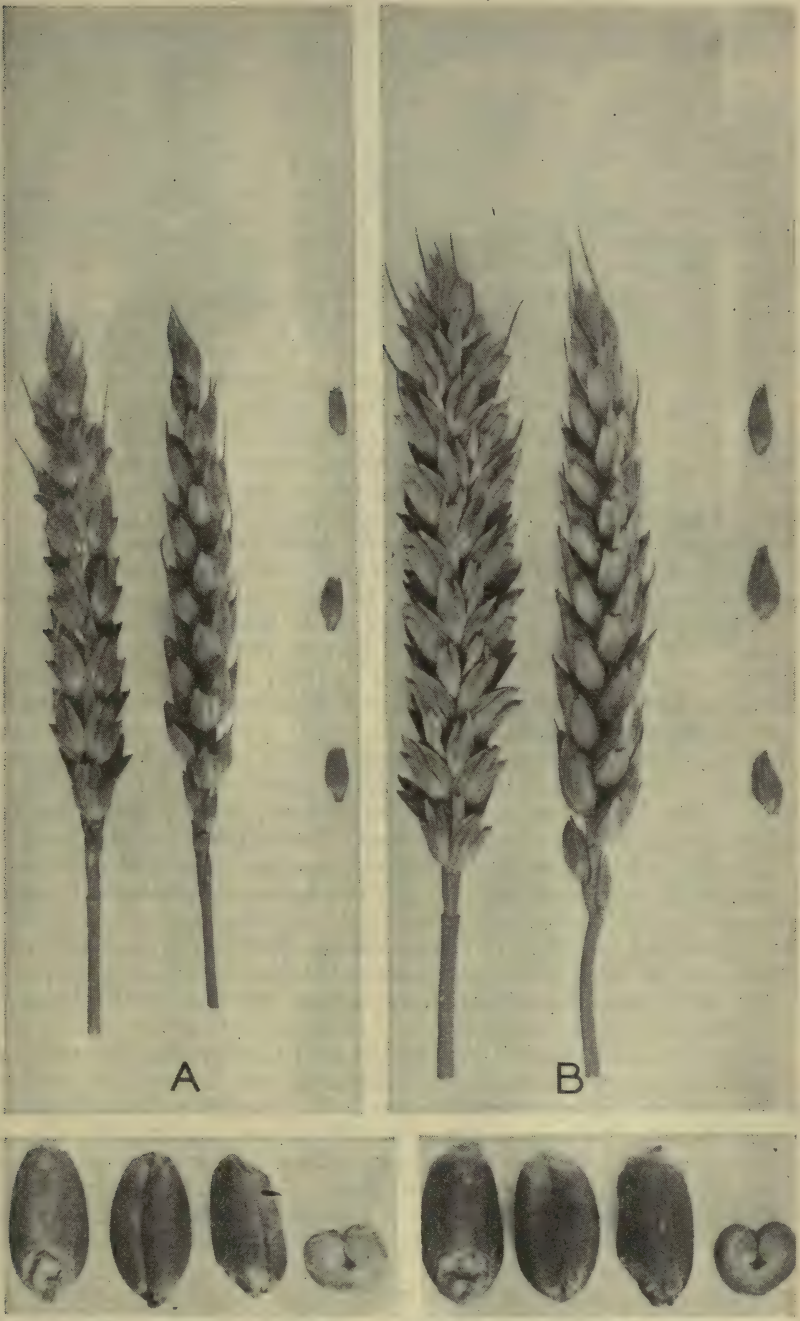

FIGURE 4.—Heads, chaff, and kernels of (A) Quality and (B) Bunyip. Heads and chaff, natural size; kernels, three times natural size.

DEFIANCE

Defiance (Pringle's Defiance) is a tall, midearly, white spring wheat having mostly slender, tapering heads. There is much variation in the size and shape of the heads and in the number and length of the short tip beards. The kernels are white and of varying degrees of size and hardness, but for the most part are midsized and rather soft. The straw is fairly stiff and does not lodge easily on irrigated land. Defiance is rather resistant to the forms of stem rust that occur along the coast of California. As grown commercially, Defiance is a mixture of several types of beardless white-kerneled wheat.

Defiance was originated in 1871 by Cyrus G. Pringle, of Charlotte, Vt., from a cross between White Hamburg and Golden Drop wheats. It was first distributed in 1878 by a seed firm and eventually found its way into the western United States. It was not entirely purified before being distributed, but since then several selections have been made.

Defiance is grown to a limited extent mostly under irrigation, in nearly all of the far Western States. It is most important in Colorado and California.

Regenerated Defiance is a taller and later variety having a larger head than Defiance. The heads are wide and nearly square at the tip. The kernels are short, hard, and angular. Regenerated Defiance was selected from Defiance by A. E. Blount, of the Colorado Agricultural Experiment Station, before 1891. It was first distributed from the Colorado station in 1907 and is now grown in Colorado, Idaho, Montana, and New Mexico, although it is not of much importance there.

Early Defiance, a strain or selection of Defiance that has been distributed in recent years by a Los Angeles (Calif.) seed firm, differs from Defiance in maturing several days earlier and in having no tip beards on the heads. The kernels are rather long and pointed. Early Defiance is grown in San Diego County, Calif., and probably in other localities. Little is known about its yielding ability and quality.

Escondido, a selection from Defiance developed in cooperative experiments at the University Farm, Davis, Calif., was reported in 1929 as having been grown on about 2,000 acres in southern California.

The strains of Defiance are adapted to the humid valleys along the California coast, where they withstand rust better than do most other varieties. They are fall sown in California and sometimes in the Willamette Valley of Oregon. They are fairly well adapted as spring wheats in the irrigated sections of southern Colorado. Defiance usually is outyielded by other varieties in northern Colorado, southern Idaho, Utah, and Arizona. The growing of the mixed, unselected, and poorer strains of Defiance should be discontinued.

WHITE FEDERATION

White Federation wheat is short and extremely early. The heads are short, erect, almost entirely free from short beards, nearly square at the tip, and do not shatter easily. The chaff is wide and thick. The kernels are short, wide, and hard. The straw is stiff and the leaves are distinctly curled. White Federation is very similar to Hard Federation, except that it has white chaff, softer kernels, and is slightly taller.

White Federation, with Hard Federation, was selected from the Federation variety, from which both probably originated by natural crossing. White Federation was introduced into the United States by the Department of Agriculture in 1916. It was first distributed in California in the fall of 1919 from the United States Plant Introduction Garden at Chico, Calif. Nearly two thirds of the acreage grown in California is in San Luis Obispo County, where it is well adapted. White Federation is equal or superior to Hard Federation in yield in Oregon and Washington. It is superior to most white-kerneled commercial varieties in bread-making qualities.

RINK

Rink wheat has wide flat heads and rather small, soft, white kernels. The heads are considered beardless, but short, sharply incurving beards occur throughout their length.

The origin of Rink is not known. The variety has been grown in Washington County, Oreg., at least since 1909. It is now grown in Washington and adjacent counties in the Willamette Valley of Oregon. It is a late-maturing variety of spring wheat, but is grown largely from fall seeding.

SURPRISE

Surprise (Pringle's Surprise) is known chiefly by the following names: Australian Club, Bay, California Club, California Gem, Excelsior, Golden Gate Club, Imperial Club, Mormon Club, Pride of California, Silver Chaff, Silver Club, Smith Club, University Gem, and White Russian. It has erect, compact heads, with clubbed tips, but is not a club wheat. The kernels are of about medium size, but appear flattened and are soft. It is a late-maturing spring wheat. There is much variation in the plants, heads, and kernels of Surprise, indicating that it contains several types.

Surprise was originated by Cyrus G. Pringle, of Charlotte, Vt., the originator of Defiance. It is the result of a cross between Chile Club (Big Club) and a variety of common wheat known as Michigan Club. After being increased, the entire supply of seed was sold as Pringle's Surprise to the United States Commissioner of Agriculture for distribution. It was found to be adapted only to the western part of the United States. In time many other names were applied to it, and its identity was almost lost. At the time of its distribution Surprise had not been purified and it still lacks uniformity. It is now grown partly under irrigation in Washington, California, Colorado, Utah, and Wyoming.

Because of its late maturity Surprise is best adapted to irrigated lands and to cool humid sections. Under such conditions it is a good-yielding variety. However, it has been replaced by Dicklow and Federation in the irrigated districts of Utah and Idaho. It has largely been replaced by Pilcraw, known locally as Thompson and White Russian, and by Jenkin in the Yakima Valley of Washington where irrigation is practiced.

ONAS

Onas is a short, fairly early variety having stiff straw, erect, oblong, compact heads with white chaff, and almost no tip beards. The kernels are white, rather short, and usually soft. Onas is a true spring wheat, but is grown from fall sowing in mild climates like that of California. In Washington and Oregon it is adapted only to spring sowing.

Onas was introduced from Australia by the United States Department of Agriculture in 1918. It was developed by F. Coleman from a cross with Federation as one parent. After having been tested in cooperative experiments in the Pacific Coast States, seed was distributed from the University Farm at Davis, Calif., in 1923.

Onas has produced good yields on farms in Monterey and adjacent counties and in the Sacramento Valley of California. It yields about the same as Federation in the more humid sections and under irrigation in the Pacific Northwest. It has yielded about the same as Baart in experiments under the extreme drought conditions at Lind, Wash. The variety seems to have an unusually wide adaptation in the Intermountain and Pacific Coast States.

In 1929 Onas was reported to be grown on about 17,000 acres in California and to a very limited extent in Oregon and Washington.

PILCRAW

Pilcraw, also known as Pilcraw Enormous, White Russian, Thompson, or Thompson Club, has erect, compact heads, distinctly clubbed at the tip. Although the variety is beardless, the upper meshes of each head have several short beards ranging in length from one half inch to more than 1½ inches. The kernels are large, thick, plump, humped, and soft. It most closely resembles Surprise, but differs from it chiefly in having larger kernels and longer tip beards.

The origin of Pilcraw has been traced to a plant found growing along the roadside in Napa County, Calif. The progeny of this plant was increased by Hugh A. Crawford, of Napa, Calif., from 1913 until 1917, when seed was first distributed. Pilcraw was formerly grown sparingly in Napa and Sacramento Counties, Calif. In 1929 it was reported only from the Yakima Valley of Washington, where it was grown on about 13,000 acres under irrigation. It is well adapted to be grown under irrigation in that valley, where it is known as White Russian or Thompson Club and where it yields about the same as Dicklow and Jenkin.

GROUP 3.—HEADS BEARDLESS; CHAFF SMOOTH, BROWN OR RED; WINTER WHEATS

The wheats listed in group 3 include three white-kerneled winter varieties, some of which are grown in both the eastern and western parts of the United States. They are grown only from fall sowing. They all have soft kernels desirable for making soft-wheat flour for biscuits and pastry. The flour is of low bread-making value.

GOLDCOIN

Goldcoin wheat is known by many names, including Abundance, American Banner, Clawson, Eldorado, Fortyfold, Gold Bullion, Golden Chaff, Gold Medal, Goldmine, Improved No. 6, International No. 6, Junior No. 6, Klondike, New American Banner, New

Soules, Niagara, Number 6, Oregon Goldmine, Plymouth Rock, Prizetaker, Prizewinner, Rochester No. 6, Soules, Superlative, Twentieth Century, White Century, White Clawson, White Eldorado, White Rock, White Russian, White Soules, White Surprise, and Winter King. Goldcoin is commonly known in the Western States as Fortyfold. It is usually known as Number 6 in New York. Some of the names listed are for supposedly selected strains of the wheat, but none can be distinguished from the bulk parent variety.

Goldcoin has erect, compact heads with golden-brown chaff. The heads usually are distinctly clubbed at the tip (fig. 5, B). The straw or stems are purplish or reddish at maturity. The kernels are midsized, soft, and white, and most of them have a rim or collar around the brush (tuft of hairs at the tip). They are rather easily shattered from the heads at maturity. Goldcoin is grown only as a winter wheat.

Several conflicting stories of the origin of Goldcoin and its various strains have been circulated. New Soules, identical with Goldcoin, has been known since 1840 and Clawson since 1865. Both originated from plants found in fields of other varieties. The wheat that later became known as Goldcoin originated from a head found about 1890 by Ira M. Green, of Avon, N.Y., in a field of Diehl-Mediterranean. Seed was distributed by several seedsmen.

Goldcoin is now grown in two widely separated areas: (1) The humid section of the North Atlantic States; and (2) the Pacific Northwest. In the latter area it is grown in both subhumid and semiarid sections. The variety is most important in the following States in the order named: Michigan, Washington, Oregon, New York, and Idaho. In 1929 nearly 900,000 acres of Goldcoin were grown in the United States (fig. 6). Goldcoin is the most important of the common white wheats.

While Goldcoin is fairly productive, it usually does not outyield all other varieties grown in the same sections. There are certain districts in Oregon and Washington, however, where Goldcoin still is the leading variety. The most important of these districts are the southern part of the Columbia Basin, the Grand Ronde Valley of Oregon, and the section surrounding Spokane, Wash. It is best adapted to sections where high winds are not common and where the binder is used to harvest the crop.

In New York, Michigan, Ohio, and Pennsylvania Goldcoin has produced good yields in comparison with those of the soft red winter varieties. However, in most of Michigan, Red Rock, a soft red winter variety, is more productive; and in most parts of the other three States Dawson has produced higher yields than has Goldcoin. If it were not for the special demand for common soft white wheat, the acreage of Goldcoin could well be reduced in the Eastern as well as in the Western States.

Goldcoin is one of the varieties of common white wheat best suited for making starchy flour for biscuits, crackers, and pastry and for the manufacture of certain whole-wheat foods. Flour from Goldcoin is not used extensively for bread making.

DAWSON

Dawson (Dawson Golden Chaff) also is called Golden Bronze, Golden Chaff, Improved Amber, and White Winter. It differs from

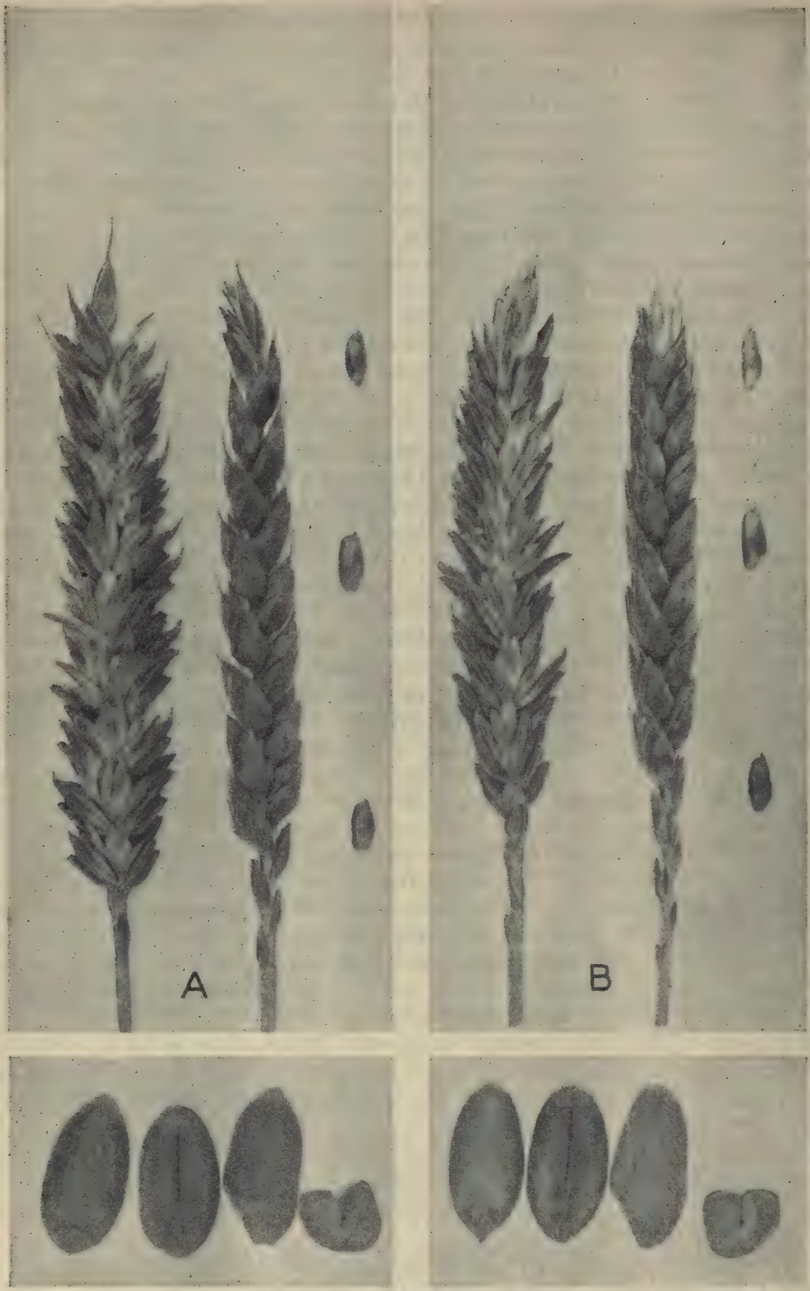

FIGURE 5.—Heads, chaff, and kernels of (A) Dawson and (B) Goldcoin. Heads and chaff, natural size; kernels, three times natural size.

Goldcoin chiefly in having white or yellow straw instead of purple and in having a square-tipped instead of a clubbed head (fig. 5, A). The kernels do not have the collar or rim around the brush. It is the most winterhardy of the white wheats.

This variety was originated from a plant found in 1881 by Robert Dawson, of Paris, Ontario, Canada, in a field of Clawson wheat. After it was found to be a high-yielding variety at the Ontario Agricultural Experiment Station, the acreage was rapidly increased.

Dawson is important in eastern Canada. It was also grown in 1929 in four States in the northeastern part of the United States. It is most important in New York and Michigan and second in importance among the true winter varieties of common white wheat grown in the United States.

In New York and Michigan Dawson yields well in comparison with other varieties. As it is a white wheat not desirable for grinding into bread flour, it is grown for special markets for biscuit and pastry flour and for breakfast cereals.

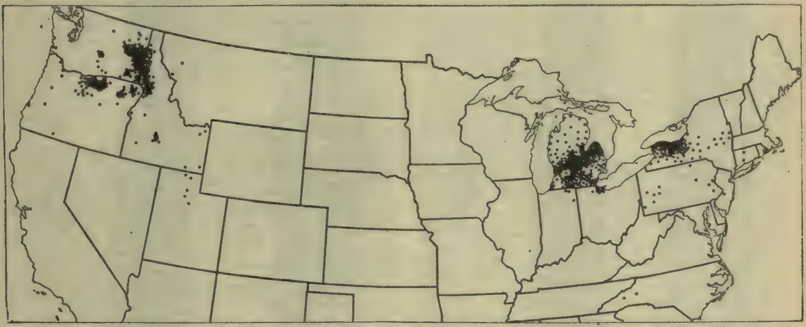

FIGURE 6.—Distribution of Goldcoin wheat in 1929. Each dot represents 1,000 acres. Estimated area, 892,000 acres.

HONOR

Honor cannot be distinguished from Dawson. However, it is slightly hardier, has a stronger straw, and produces better yields than Dawson. This wheat was selected from Dawson at the Cornell University Agricultural Experiment Station, Ithaca, N.Y. After having been tested for several years at the experiment station and on farms in New York, it was offered for sale in 1920.

Honor has outyielded Dawson in comparative tests in New York and apparently is the highest-yielding white wheat grown there.

GROUP 4.—HEADS BEARDLESS; CHAFF SMOOTH, BROWN OR RED; SPRING WHEATS

The two spring wheats in group 4 are rather promising.

FEDERATION

Federation is a short, fairly early spring wheat, having erect, oblong to slightly tapering heads and brown chaff. The heads are stiff, rather compact, and have almost no tip beards (fig. 7, A). The kernels are white, rather short, and usually soft. Although Federation is a spring wheat, it can be grown from fall sowing in mild climates like those of California, sections of Umatilla County, Oreg., and Walla Walla County, Wash.

Federation was originated from a cross made by William Farrer, of New South Wales, Australia, between Purplestraw and Yandilla wheats. It is the leading variety in Australia. It was introduced

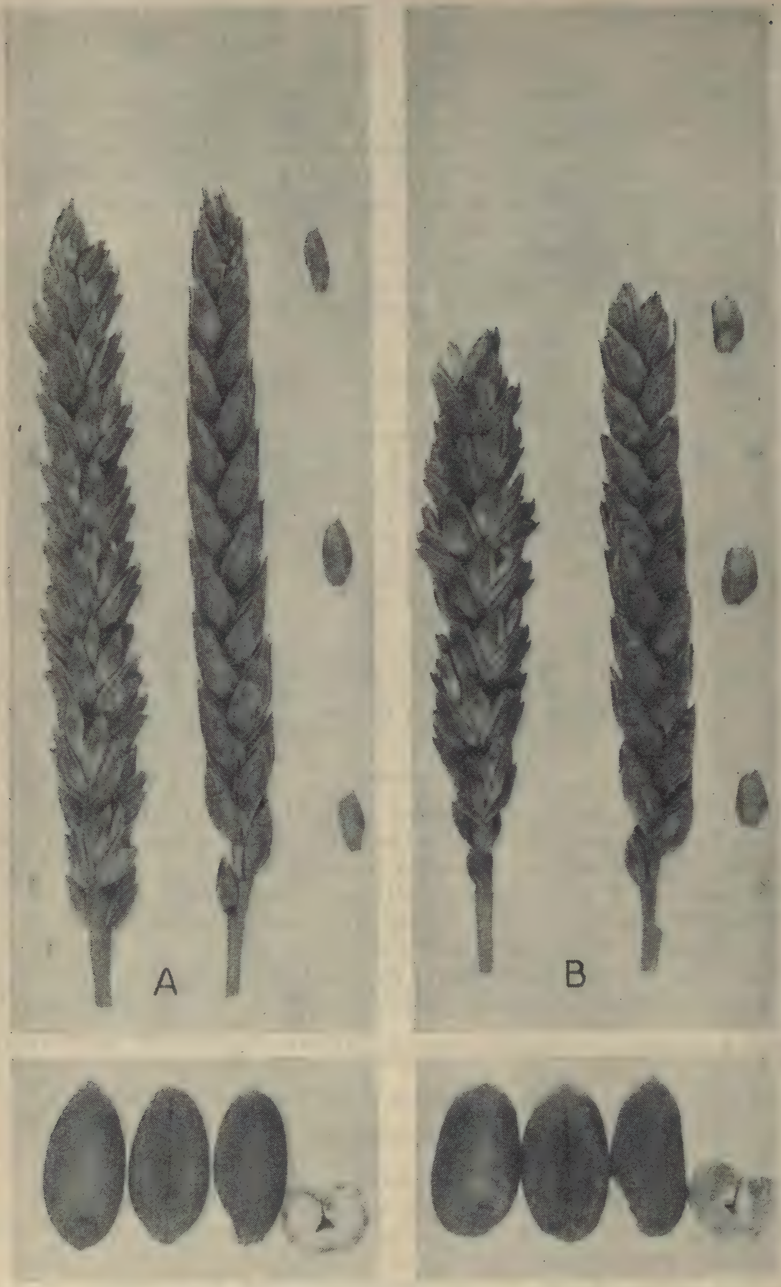

FIGURE 7.—Heads, chaff, and kernels of (A) Federation and (B) Hard Federation. Heads and chaff, natural size; kernels, three times natural size.

into the United States in 1914 by the Department of Agriculture. After having been tested in the Pacific Coast States for several years, it was first distributed to farmers in Oregon in the spring of 1920 from the Sherman County Branch Station, Moro, Oreg. About 1,000 acres were grown in Oregon in 1922. By 1924 more than 32,000 acres were produced, and in 1929 it was estimated that about 753,000 acres were grown (fig. 8). Federation is raised extensively in Oregon, Washington, and Idaho, and on a smaller acreage in California, Montana, Utah, Nevada, Wyoming, and Colorado. It has produced exceptionally high yields under irrigation in southeastern Oregon and southern Idaho and doubtless should replace all other spring varieties, with the exception of Dicklow, in these sections.

Federation is less subject to lodging than Dicklow. It produces flour of a slightly yellow color, which sometimes meets objection from the milling trade.

Federation, although a spring wheat, is grown extensively from fall seeding on the productive lands of Umatilla County, Oreg., and Walla Walla County, Wash. It does not often winter-kill in this area because the winters are mild. It is preferred to most other varieties because of its short, stiff straw and high yields, and also because of the possibility that it can be sown in the spring in case of winter-killing.

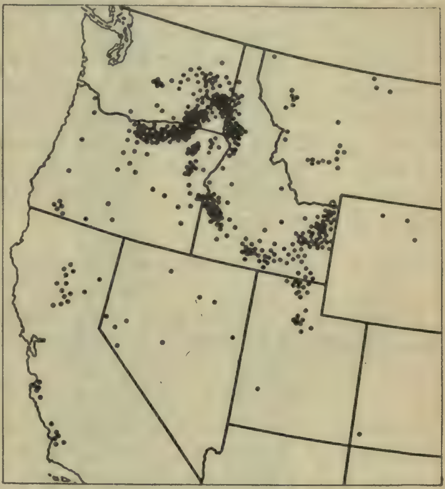

FIGURE 8.—Distribution of Federation wheat in 1929. Each dot represents 1,000 acres. Estimated area, 753,000 acres.

HARD FEDERATION

Hard Federation differs from Federation chiefly in being shorter and earlier and in having harder kernels. The heads of Hard Federation are erect, short, stiff, and compact, and almost free from short beards (fig. 7, B). The kernels are short, broad, thick, hard, and translucent. The straw is white and stiff and the leaves distinctly curled. Hard Federation is a true spring wheat, but is grown in California from fall sowing.

Hard Federation was selected from Federation about 1908 by J. T. Pridham at the Cowra Experiment Station in New South Wales, Australia. It was introduced into the United States by the Department of Agriculture in 1915 and was first distributed in 1920 in Oregon and California from the Sherman County Branch Station, Moro, Oreg., and the United States Plant Introduction Garden, Chico, Calif.

About 24,000 acres of Hard Federation were grown in the Grand Ronde Valley of eastern Oregon, and a smaller acreage in Sherman and Wasco Counties. It was also grown to some extent in California, eastern Washington, and Idaho.

In bread-making qualities Hard Federation is superior to almost all other common white wheats with the exception of Quality. It is nearly equal in this respect to the best varieties of hard red spring wheat.

GROUP 5.—HEADS BEARDLESS; CHAFF VELVETY, WHITE; WINTER WHEAT

Silvercoin is the only variety in group 5. It is of relatively small importance.

SILVERCOIN

Silvercoin (Hansen) wheat has beardless heads, with velvety or hairy white chaff and soft white kernels. It is of medium height and maturity. The heads are nearly erect and distinctly clubbed at the tip. The kernels are rather short and wide. The variety can be grown only from fall sowing.

Silvercoin was originated from a plant found in a field of mixed Goldcoin and Sonora wheats on the farm of Ephraim Hansen, near Mendon, Utah. It was increased and distributed in that vicinity and is now grown in Box Elder and Cache Counties, Utah.

Little is known concerning the value of Silvercoin. It probably yields less than Turkey, the hard red winter variety, in the district where it is grown.

GROUP 6.—HEADS BEARDLESS; CHAFF VELVETY, BROWN OR RED; SPRING WHEATS

Group 6 contains two very distinct varieties of wheat. One of these, Sonora, is rather important.

SONORA

Sonora, known also as Ninety-Day, Red Chaff, and White Sonora, is early and rather short and has erect, short, compact, oblong heads (fig. 9, A). The kernels are small, soft, and white. The outer chaff on each mesh of the heads has longer points or beaks than those of any other variety of beardless wheat grown in the United States. Sonora is a spring wheat, but most of it is grown in California and Arizona from fall sowing.

The origin of Sonora is unknown. The variety was grown in Sonora, Mexico, in the eighteenth century and is reported to have been brought to California by the Spanish Fathers 100 or 150 years ago. It is the oldest wheat grown in California and Arizona and still is the leading variety grown by the Indians in those States. In recent years samples of wheat identical with Sonora have been obtained from South Africa, but their history is unknown.

Sonora is grown in different quantities in all of the States west of the Great Plains area. In 1919 more than 266,000 acres were grown. In 1929 less than 92,000 acres were grown, more than two thirds of which were in California, mostly in the upper San Joaquin Valley.

Because of its earliness, Sonora often produces high yields under unfavorable conditions. Under most conditions in California, Arizona, and Utah it is outyielded by Baart and frequently by other varieties, such as Bunyip and Pacific Bluestem. It is a high-yielding variety in the upper San Joaquin Valley of California, and often produces high yields in southern Arizona, especially in unfavorable seasons. Outside of sections of California and Arizona, Sonora is outyielded by several other varieties.

Sonora wheat is used largely in the manufacture of breakfast foods. The flour is not desirable for bread making. It is graded with club wheats in the official grain standards because of its low quality and short type of kernel.

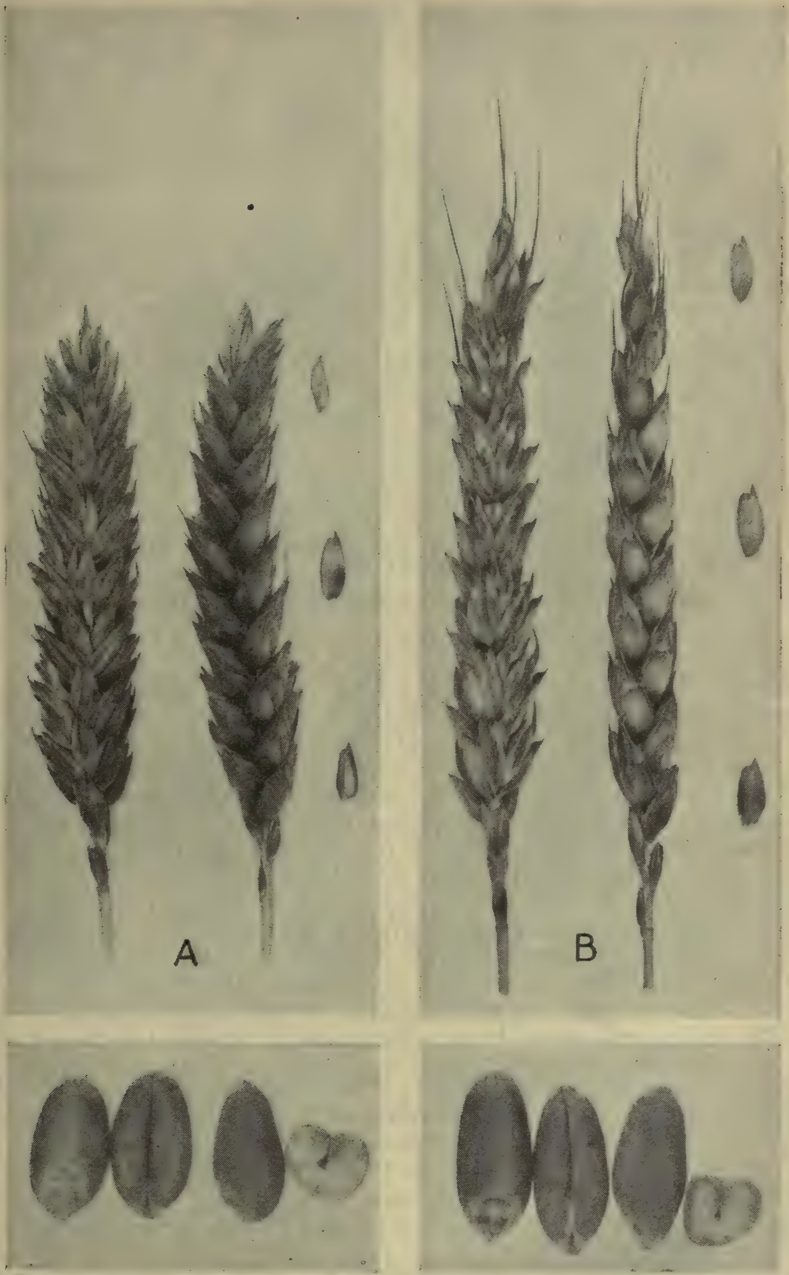

FIGURE 9.—Heads, chaff, and kernels of (A) Sonora and (B) Galgalos. Heads and chaff, natural size; kernels, three times natural size.

GALGALOS

Galgalos wheat, known also as Russian Red and Velvet Chaff, differs from Sonora chiefly in being taller and later and in having longer, looser heads and longer kernels. The heads are inclined, long, slender, open, and tapering (fig. 9, B). The chaff is light brown. The kernels are rather long, slender, and soft. The straw is weak, so that the plants lodge easily. The leaves have a bluish appearance, owing to the presence of white hairs on the surface. Before shooting to head, the plants lie nearly prostrate on the ground like those of winter wheats. When fall sown, Galgalos will survive rather severe winters.

The variety was introduced into the United States from the Erivan Government in Transcaucasia, Russia, by the United States Department of Agriculture in 1903. It was distributed in California and other States and is now grown in northern California and central Oregon.

Galgalos has produced high yields under dry conditions in several States. Because of its weak straw it is not a desirable variety for many sections. It would not be suitable for growing in the Great Plains area because of its white kernels. It could be partly replaced by other varieties, such as Baart and Federation, in the sections of California and Oregon where it is now grown.

GROUP 7.—HEADS BEARDED; CHAFF SMOOTH, WHITE OR YELLOW; SPRING WHEATS

Baart and Propo are the two varieties included in group 7.

BAART

Baart (Early Baart) wheat is known also as Arizona Baart, Columbia, Diener No. 18, and White Columbia. It has slender, tapering, rather open heads and smooth white chaff (fig. 10, B). The heads and beards are of medium length and sometimes rather short. The kernels are yellowish, long, somewhat pear shaped, and soft to semihard. The variety is rather early and of medium height. The straw is white but not very strong, as the sheath tends to bend and sometimes lodges at maturity. Although Baart is a spring wheat, it is grown from fall sowing in California and Arizona.

Baart has been grown sparingly in Australia for many years. It was introduced into the United States by the Department of Agriculture in 1900. Seed was distributed for experimental purposes in several parts of the country. From the seed received by the Arizona Agricultural Experiment Station distribution was made in Arizona, and the variety was well established in that State by 1914. From Arizona it spread to Washington, Idaho, and California. Large quantities were distributed in Oregon by the Sherman County and Harney County Branch Stations. It is now grown in all the States west of the Great Plains area. More than 765,000 acres were grown in the United States in 1929 (fig. 11). It is most important in Washington, California, and Idaho.

Baart has shown excellent adaptation to the dry lands in the Pacific Northwest. It has outyielded all other spring varieties in sections of Washington where the rainfall is less than 15 inches. It is outyielded as a spring variety by Federation on dry lands in eastern Oregon. It is the highest-yielding variety at high altitudes in southeastern Oregon and has produced excellent yields in the Sacramento and lower San Joaquin Valleys of California, where it has usually outyielded Pacific Bluestem and partly replaced it. Baart

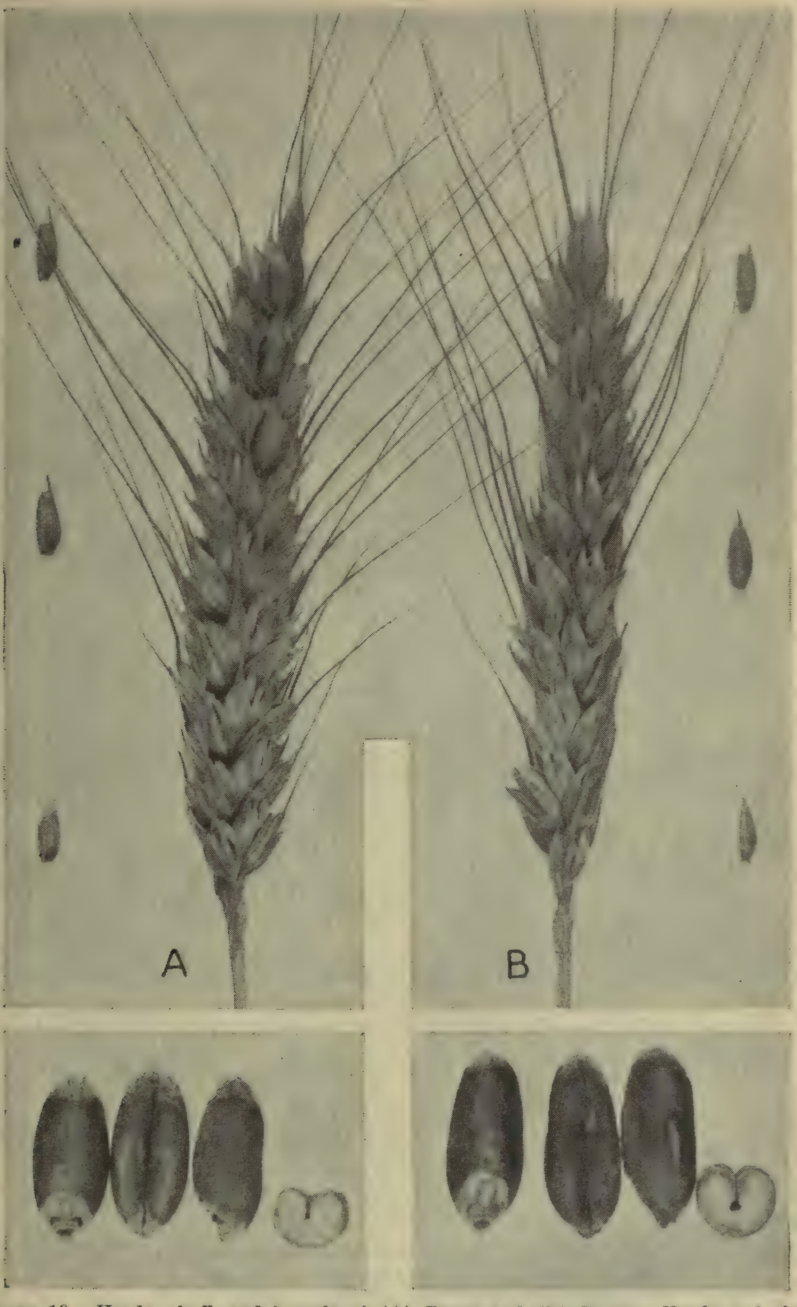

FIGURE 10.—Heads, chaff, and kernels of (A) Propo and (B) Baart. Heads and chaff, natural size; kernels, three times natural size.

usually has outyielded all other varieties on the irrigated lands of southern California and Arizona. It cannot compete with Dicklow or Federation on the irrigated lands of southern Idaho, Oregon, and Utah, and is not satisfactory for humid sections.

In bread-making qualities Baart is superior to most of the common white wheats, including Pacific Bluestem, but is not equal to the best varieties, such as Quality and Hard Federation. Its good bread-making qualities are due to the fact that it is grown largely in dry areas conducive to the production of high-protein grain.

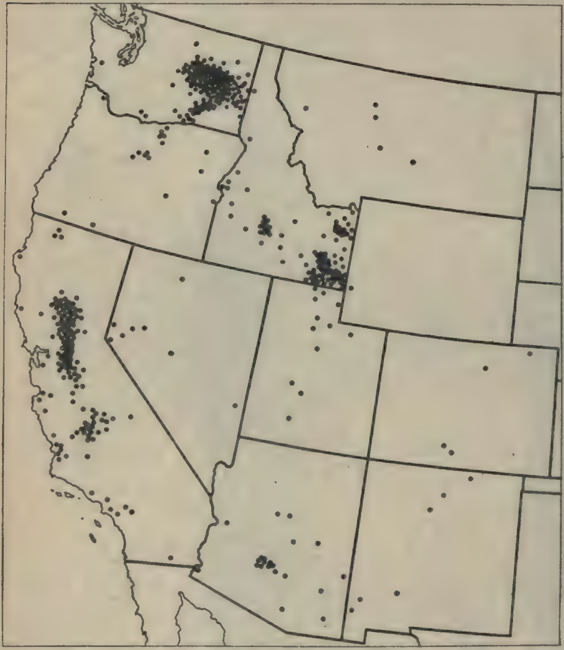

FIGURE 11.- Distribution of Baart wheat in 1929. Each dot represents 1,000 acres. Estimated area, 767,000 acres.

PROPO

Propo, or Proper, wheat differs from Baart in having a faintly purple straw and smaller, softer, and whiter kernels (fig. 10, A). Like Baart, it is a spring wheat, but it is grown from fall sowing in California.

Propo originated from some heads found, probably during the early seventies, in a wheat field belonging to a Mr. Proper, in Sutter County, Calif. It was first known as Proper, but the spelling of the name soon became confused. The wheat was increased and distributed in the Sacramento Valley. Propo is now grown in the costal valleys of California. It is not an important variety, as less than 20,000 acres were reported grown in 1929.

The yields of Propo usually have been smaller than those of other varieties, such as Baart, White Federation, and Bunyip, grown in the same section. The growing of Propo, therefore, should be discontinued.

ADDITIONAL VARIETIES

Several other distinct common white varieties were reported grown on less than 5,000 acres each in the United States in 1929. These varieties will not be discussed as none is recommended for extensive growing. These varieties include Touse, "Zimmerman", Sevier, Kofod, Powers Club, Democrat, Palisade, Martin, Foisy, Allen, Longberry No. 1, Windsor, New Zealand, Pusa No. 4, Genesee Giant, Arizona No. 24, White Odessa, and Axminster.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1708

VARIETIES of CLUB WHEAT

1862 1889

THE VARIETIES OF CLUB WHEAT differ from others in having short compact heads and small kernels. They are grown almost exclusively in the region west of the Rocky Mountains and are most important in Washington, Oregon, Idaho, and California. They are best adapted to the subhumid sections within these States. About 725,000 acres of club wheat are grown annually in the United States, which is only 1.2 percent of the total wheat acreage.

Owing to their soft texture and low protein content, club wheats are not well adapted for bread making. They are either exported or used in making pastry and biscuit flour.

Twelve distinct varieties of club wheat are grown commercially. Only three, none of which is important, have red kernels. They are grown from both fall and spring sowing. The older varieties are of Chilean origin. Five of the newer varieties are of hybrid origin, resulting from crosses between club and common wheats.

Hybrid 128 is the leading variety of club wheat. It is a white-kerneled winter wheat and is best adapted to the subhumid sections of eastern Washington, Oregon, and northern Idaho. It is very productive, but is also very susceptible to smut.

Albit, a new variety distributed by the Washington Agricultural Experiment Station in the fall of 1926, is resistant to some forms of bunt and is equal to Hybrid 128 in yield in the more humid sections of eastern Washington.

Jenkin is the best-yielding variety in the humid sections and under irrigation. It is a white-kerneled spring wheat, but is grown from both fall and spring sowing in eastern Washington and northern Idaho.

Hybrid 123 is the most important and productive red-kerneled variety and can be grown from both fall and spring sowing.

Hybrid 143, Little Club, Big Club, Redchaff, and several other white-kerneled spring wheats were formerly important, but they are now being replaced by more productive varieties.

This bulletin is a revision of and supersedes Farmers' Bulletin 1303, The Club Wheats.

Washington, D.C. Issued October 1933

VARIETIES OF CLUB WHEAT[1]

By J. Allen Clark, *senior agronomist*, and B. B. Bayles, *associate agronomist*, *Division of Cereal Crops and Diseases, Bureau of Plant Industry*

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DESCRIPTION

THE CLUB WHEATS have short, thick, and very compact heads and small kernels. Because of these distinctive characters, they usually are placed in a different division or so-called subspecies (*Triticum sativum compactum*) from the common bread wheats (*T. sativum vulgare*). About 725,000 acres, or 1.2 percent of the wheat acreage of the United States, are annually devoted to the production of club wheats. There are 12 distinct varieties commercially grown; 3 of these have red kernels. Some are grown from both spring and fall sowing, others only from fall sowing. The grain of most of the varieties is soft and inferior to that of other classes of American wheats for making light bread. Club wheats are largely exported to western Europe and the Orient. Flour made from club wheats in the United States is used largely for biscuits and pastry.

Under the official grain standards of the United States the white-kerneled varieties are graded in the subclass (*c*) western white of the class V white wheat, and the red-kerneled varieties in the subclass (*b*) western red of the class IV soft red winter wheat.

Not all so-called club wheats are true club varieties. Varieties of common wheat having clavate, or club-shaped, heads (widest at the tip) are sometimes erroneously called club wheats. The heads of most varieties of the true club wheat are not club-shaped but are more or less oblong, that is, as wide at the bottom as at the top.

Surprise, known also as California Club, California Gem, Golden Gate Club, Imperial Club, Silver Club, or Smith Club, and Dicklow are white-kerneled common wheats having clavate, or club-shaped, heads, but they should not be confused with the true club wheats. Red Russian, sometimes known as Australian Club, also is a common wheat of the soft red winter class. The wheat known in the Southeastern States as Club, Club Head, Double Head, Stub Head, and by numerous other names, is not a club wheat but is the Fultzo-Mediterranean, a variety of soft red winter common wheat. Sonora is sometimes classed as club wheat, because its quality is similar to that of the club varieties, but it is a common wheat and in many characters is very different from the club wheats.

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[1] The information in this bulletin is based upon (1) varietal experiments conducted by the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U.S. Department of Agriculture, in cooperation with State agricultural experiment stations; (2) classification studies of all American wheat varieties; (3) a survey of the wheat varieties of the United States, in cooperation with the Bureau of Agricultural Economics, based upon about 10,000 returns from 74,000 questionnaires sent to crop correspondents; and (4) personal observations for several years by the writers in the wheat fields in the States where these varieties are grown.

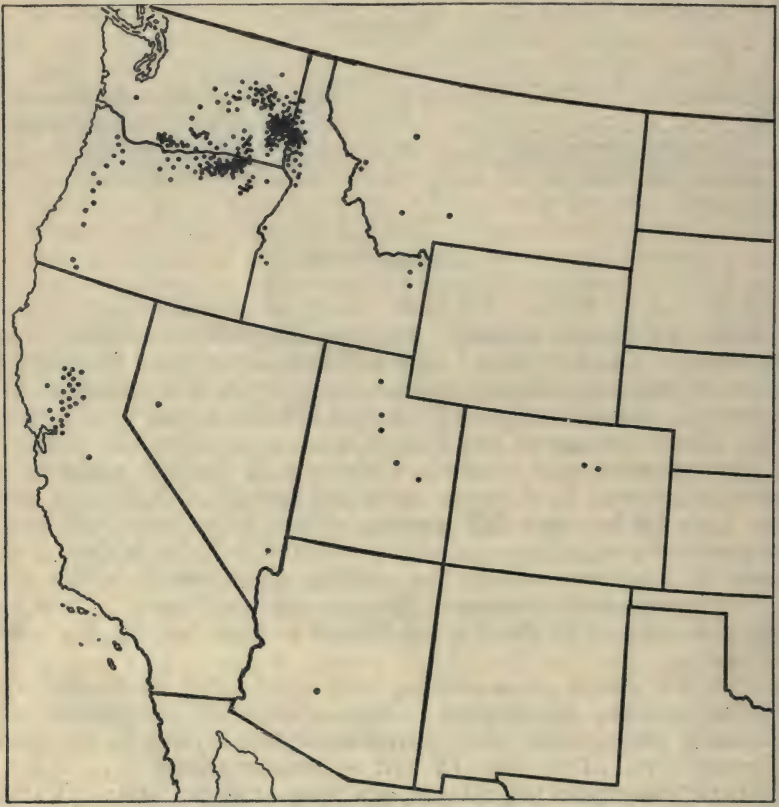

FIGURE 1.—Distribution of club wheats in the United States in 1929. Each dot represents 2,000 acres. Estimated area, 725,214 acres.

WHERE GROWN

Washington, Oregon, Idaho, and California lead in the production of club wheats. In these States club varieties made up 16, 17, 7, and 9 percent, respectively, of the total wheat acreage in 1929. A smaller acreage is grown in Utah and Montana. Only very limited quantities, if any, are grown east of the Rocky Mountains. In these Western States the club wheats are grown principally in the subhumid sections. Their distribution in the United States is shown in figure 1.

The club wheats are best adapted to the intermountain sections of the Pacific Coast States, where they are now largely grown. This area is characterized by rather mild, rainy winters and dry summers. Club wheat cannot be successfully grown in regions where rainy or humid weather prevails at ripening time, or where stem rust is common. It cannot be grown as a winter wheat in sections having severe winters. Club wheats therefore should not be sown in the Great Plains area or in the eastern United States.

In the intermountain sections of the Pacific Coast States club wheats are well adapted, partly because the chaff and heads are firm or tough and seldom shatter in spite of the dry windy weather. For these reasons club wheats are well adapted to being harvested with the header or combined harvester, as the wheat often is allowed to stand for several weeks after it is ripe before being harvested. The stems of club wheats in general are strong, stiff, and resistant to lodging. The meshes (spikelets) of the short thick heads contain from three to eight kernels and are closely crowded. Owing to this compactness many of the kernels are lopsided or pinched. They also are usually soft and starchy, partly owing to yellow berry. Under favorable climatic conditions club wheats are from medium height to tall, although under dry conditions they may be short. In general, these wheats are taller than the common wheat varieties grown in the Western States.

Owing to the soft texture of the kernels of most of the club varieties and to the fact that these wheats are grown chiefly in sections producing wheat of low protein content, the grain of this class of wheat is not well suited for the production of bread flour under modern commercial bakeshop practice. Much of the club wheat grown in the United States is exported, and the remainder is used largely in making pastry and biscuit flour and in blending with flour of other classes of wheat for breadmaking.

VARIETIES

The older varieties of club wheat grown in the United States are of Chilean origin. They were imported from Chile into California and Oregon during the period from 1850 to 1870, when these States were being settled and developed. Several cargoes of club wheat were received and used for seed in both of these States during this period.

Several new varieties have been developed from these early introductions. Some have been developed from mixtures found in fields. It is probable that some of the new types have arisen from natural crossing with varieties of common wheat.

No fewer than five varieties of club wheat now grown commercially were developed by artificial hybridization at the Washington Agricultural Experiment Station. Four of these varieties are the result of crosses between Little Club and different varieties of common wheat made by W. J. Spillman. Because they retain the characteristics of club wheat they are still classed as such.

For convenience in discussion, the club wheats are divided into five groups, on the basis of head and kernel characters.

Group 1.—Heads beardless; chaff smooth, white or yellow; kernels white: Little Club, Big Club, Hybrid 128, Albit, Hybrid 143, Hybrid 63.

Group 2.—Heads beardless; chaff smooth, white or yellow; kernels red: Hybrid 123.
Group 3.—Heads beardless; chaff smooth, brown or red; kernels white: Jenkin, Redchaff, Bluechaff.
Group 4.—Heads beardless; chaff velvety, white or yellow; kernels red: Coppei.
Group 5.—Heads bearded; chaff smooth, brown or red; kernels red: Mayview.

GROUP 1.—HEADS BEARDLESS; CHAFF SMOOTH, WHITE OR YELLOW; KERNELS WHITE

The most important of the club wheat varieties are included in group 1. Four of the six varieties are spring and two are winter wheats.

LITTLE CLUB

Little Club, or Small Club, is a spring wheat but is often grown for fall sowing. It has longer and more slender heads and kernels than the other club varieties. The heads of Little Club usually are 2 to 2½ inches long and oblong in shape (fig. 2, A). The plants are tall, erect, and late.

The origin of Little Club wheat is not definitely known, but the variety is believed to have been introduced from Chile. It probably was one of the first wheats grown in the Columbia Basin section of Oregon, and it is believed to have been grown also in California at an early date. It is reported to have been grown in Yolo County, Calif., as early as 1878. It was formerly the leading variety in eastern Oregon and Washington, but in recent years has been largely replaced by more productive varieties.

Little Club produces fair yields under favorable conditions, but it is not well adapted to districts where the rainfall is limited. In general, it could be advantageously replaced by other varieties of club or common wheats. Several varieties of common white wheat will outyield Little Club when fall sown in the Sacramento Valley of California and also when spring sown in Oregon and Washington. In the latter-named States some true winter wheats usually produce higher yields than does Little Club from fall sowing. Among these is Hybrid 128, a club wheat.

BIG CLUB

Big Club—known also as Big Four, Chile Club, Crookneck Club, Montezuma Club, and Salt Lake Club—differs from Little Club in having wider, shorter, and thicker heads and wider and more rounded kernels (fig. 2, B). Its chief characteristics are the curves and crooks in the stem immediately below the head. For this reason it is often called Crookneck Club. In spite of the curves in the stems, the heads of Big Club are erect or nearly so.

This variety is reported to have been introduced into Oregon from Chile about 1870. However, it was grown in California as early as 1866 and was first known as Chile Club and as Oregon Club. It was formerly grown extensively in the Pacific Coast States, but only about 4,000 acres were grown in 1929. Big Club is still grown in scattered areas in California, Idaho, Montana, Oregon, Utah, and Washington.

The yields of Big Club usually have been lower than those of Little Club and of most other varieties in nearly all sections where it is grown. This wheat should be dropped from cultivation.

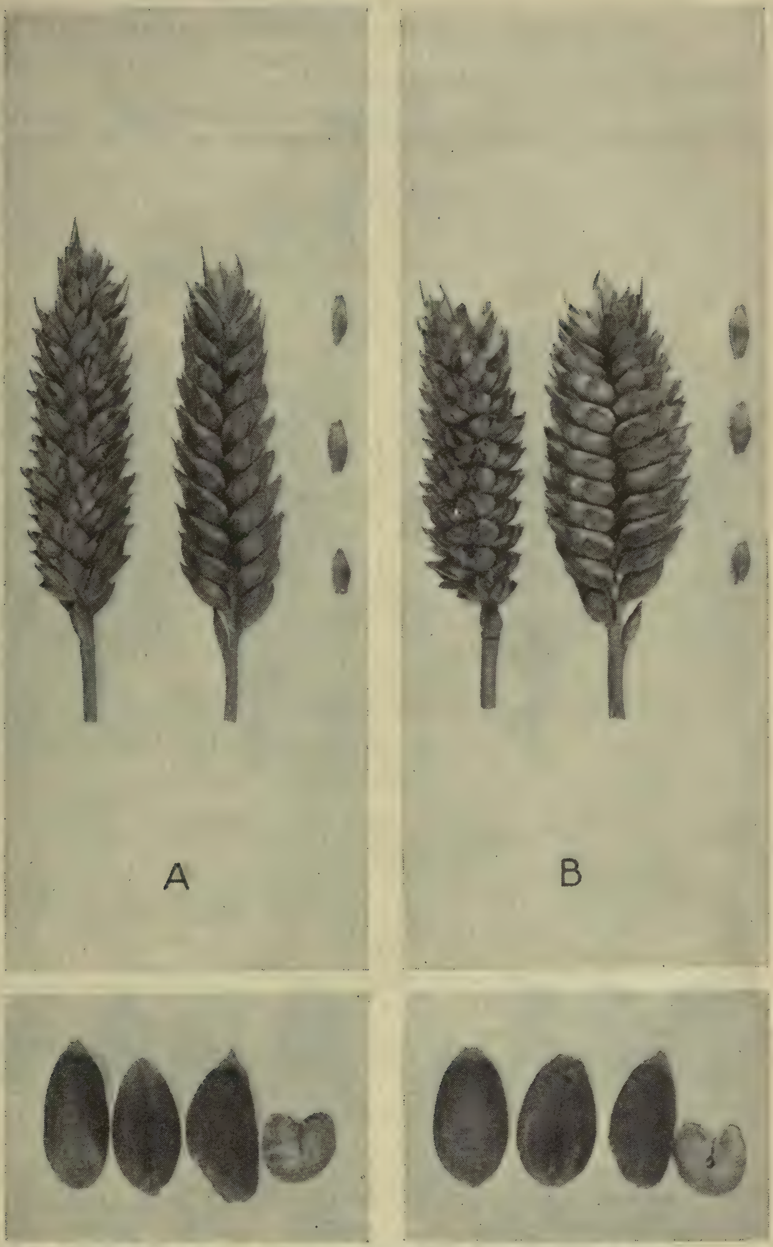

FIGURE 2.—Heads, chaff, and kernels of (A) Little Club and (B) Big Club. Heads and chaff, natural size; kernels, three times natural size.

HYBRID 128

Hybrid 128 (Washington Hybrid No. 128) is a winter wheat and cannot be successfully grown from spring sowing. The heads of this variety (fig. 3, A) can scarcely be distinguished from those of Big

Club. The kernels of the two varieties also are similar, except that those of Hybrid 128 are more pinched and irregular in shape. The plants of Hybrid 128 are of medium height. The variety is very susceptible to bunt or stinking smut.

It was originated at the Washington Agricultural Experiment Station from a cross between Jones Fife, a soft red winter wheat, and Little Club. The cross was made in 1899 by W. J. Spillman. After being selected and tested for 8 years, this new winter club wheat was distributed to farmers by the Washington station. It has since become the most important variety of club wheat.

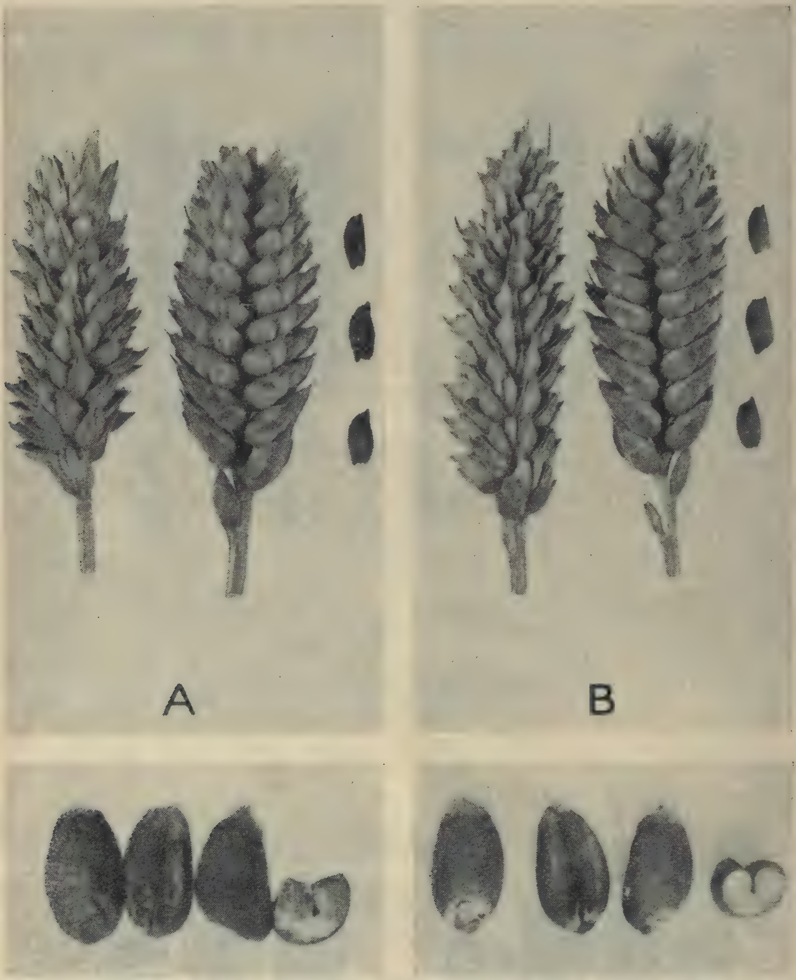

FIGURE 3.—Heads, chaff, and kernels of (A) Hybrid 128 and (B) Albit. Heads and chaff, natural size; kernels, three times natural size.

Hybrid 128 is grown extensively in the southeastern part of Washington and in adjoining districts in Idaho and Oregon. It is most important in Whitman and Walla Walla Counties, Wash., and in

Umatilla County, Oreg. It was estimated that more than 350,000 acres were grown in 1929, but since then its acreage has decreased somewhat.

This variety is being replaced in Whitman and Columbia Counties, Wash., by Albit, which is resistant to some forms of bunt, and in Umatilla County, Oreg., and Walla Walla County, Wash., by Federation, a common white spring wheat. Federation has shorter, stiffer straw and is more productive than Hybrid 128 in sections where it does not winterkill when fall sown. The distribution of Hybrid 128 in 1929 is shown in figure 4.

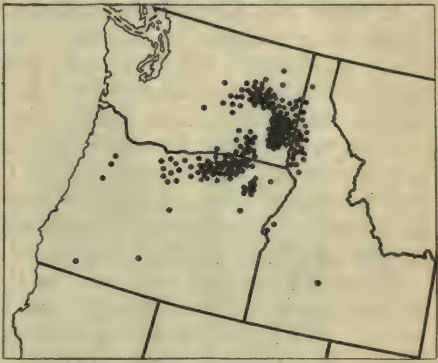

FIGURE 4.—Distribution of Hybrid 128 wheat in 1929. Each dot represents 1,000 acres. Estimated area, 357,000 acres.

ALBIT

Albit is very similar in plant characters to Hybrid 128, but differs in being resistant to some forms of bunt. The mature heads (fig. 3, B) are less harsh to the touch than those of Hybrid 128. It was developed by the Washington Agricultural Experiment Station from a cross made by E. F. Gaines in 1920 between Hybrid 128 and White Odessa. The selection, which later was named Albit, was made in 1923 and released for commercial distribution in the fall of 1926.

It was estimated that this variety was grown on nearly 80,000 acres in 1929; it is now extensively grown in Whitman and Columbia Counties, Wash. The distribution of Albit in 1929 is shown in figure 5. It is best adapted to the humid sections of eastern Washington, where its yields are equal to those of Hybrid 128. Outside of this section, in areas where a club wheat is desired, Hybrid 128 seems to be better adapted than Albit, which is a true winter wheat and will not head from spring seeding.

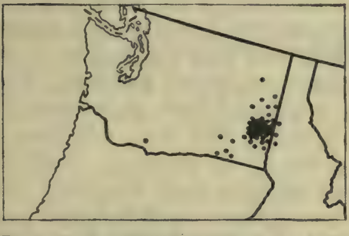

FIGURE 5.—Distribution of Albit wheat in 1929. Each dot represents 1,000 acres. Estimated area, 78,000 acres.

HYBRID 143

Hybrid 143 (Shot Club) has very short, blunt, blocky heads and small, short, white kernels. It is a spring wheat but is more or less intermediate in its habit of growth and is grown from both fall and spring sowing. When sown late in the spring it spreads out on the ground like a winter wheat; heading and ripening, therefore, are somewhat delayed and yields are comparatively poor. The plants are of medium height.

This variety was originated at the Washington Agricultural Experiment Station from a cross made in 1899 between Little Club and White Track, the latter a common white winter wheat. It was distributed by the Washington station in 1907.

Hybrid 143 is grown sparingly in several counties in southeastern Washington and adjacent Idaho. About 10,000 acres of the variety were grown in 1929. It usually does not yield so well as do other varieties, being outyielded by Hybrid 128 when fall sown and by Jenkin, as well as several common varieties, when spring sown. Hybrid 143 could profitably be replaced by more productive varieties.

HYBRID 63

Hybrid 63, sometimes called Turkey Hybrid, differs from the other club wheats in having harder kernels. The heads resemble those of Hybrid 143 in shape, but the outer chaff (glumes) of each mesh is longer and narrower. It is a spring wheat, although it usually is fall sown. The plants are of medium height.

This variety was produced at the Washington Agricultural Experiment Station by crossing Little Club and Turkey, the latter a hard red winter wheat. Hybrid 63 was distributed to farmers in 1907. It is not an important variety and is grown only to a very limited extent in Walla Walla County, Wash., and Wasco County, Oreg.

Hybrid 63 is not so hardy as the true winter varieties and should be replaced by Hybrid 128 or better-adapted varieties of winter wheat. As a spring wheat it does not yield so well as do several of the common white wheats.

GROUP 2.—HEADS BEARDLESS; CHAFF SMOOTH, WHITE OR YELLOW; KERNELS RED

Group 2 includes only one commercial variety.

HYBRID 123

Hybrid 123 is usually designated commercially as Red Hybrid or Red Walla and is graded in the subclass (*b*) western red under the official grain standards. It is a spring wheat and has rather short beardless heads with smooth white chaff and small red kernels. The kernels when free from yellow berry are semihard, but, as commonly grown, they usually appear starchy. Hybrid 123 was originated from a cross between Little Club and Jones Fife made in 1899 by the Washington Agricultural Experiment Station and was first distributed in 1907. About 26,000 acres were grown in Klickitat and Whitman Counties, in eastern Washington, in 1929. It is fairly high yielding and in some sections outyields Hybrid 128, but its market price is usually lower.

GROUP 3.—HEADS BEARDLESS; CHAFF SMOOTH, BROWN OR RED; KERNELS WHITE

The club wheats of group 3 are tall and have midsized to large heads for club varieties, and strong stems. In general, they are adapted to districts having an annual precipitation of more than 15 inches. Jenkin is the leading variety.

JENKIN

Jenkin (Jenkin's Club) is somewhat similar to Little Club, except that it has brown or red chaff and shorter, wider kernels (fig. 6, A).

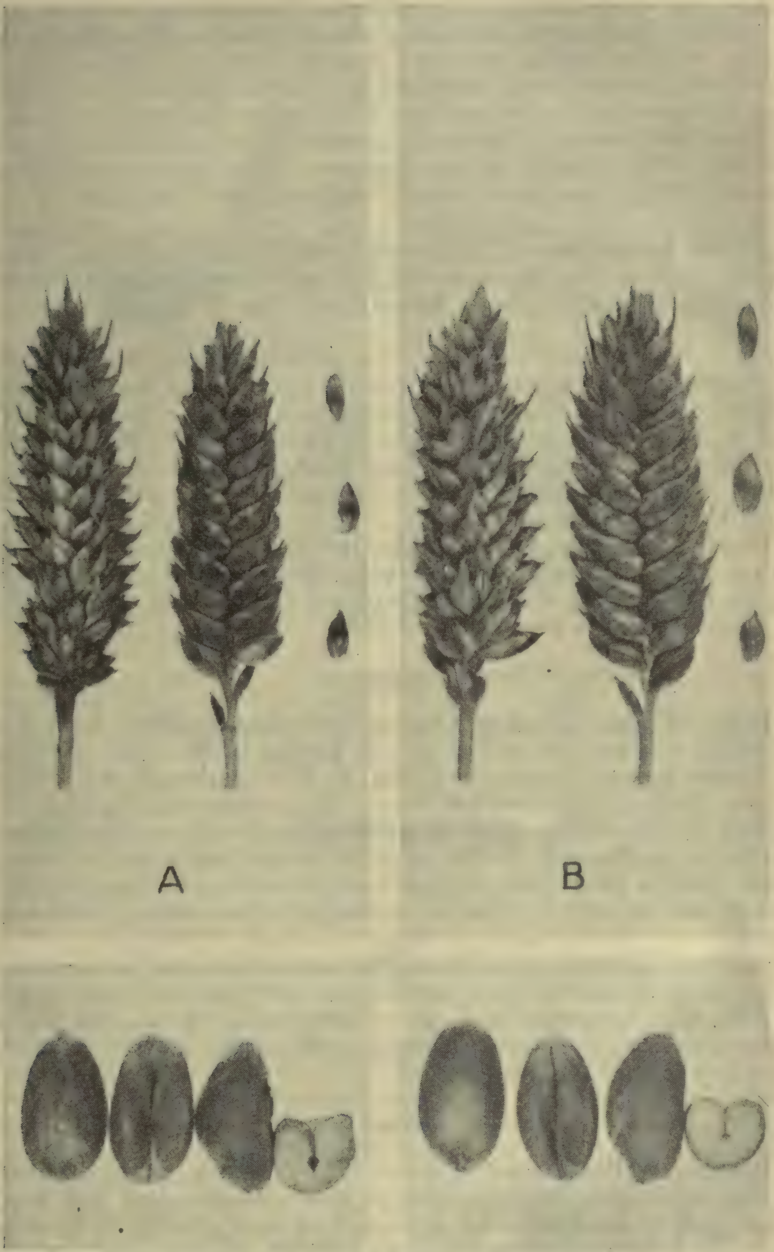

FIGURE 6.—Heads, chaff, and kernels of (A) Jenkin and (B) Redchaff. Heads and chaff, natural size; kernels, three times natural size.

The heads are oblong and about 2 inches in length. The plants are very tall and late, taller than those of most common wheats grown in the United States. It is a spring wheat but is often fall sown.

The origin of Jenkin is not known. The variety has been grown in eastern Washington at least since 1895 and in the Walla Walla Valley of Washington and in Umatilla County, Oreg., since 1900. About 90,000 acres were reported in 1929 in southeastern Washington, in Umatilla County and the Willamette Valley of Oregon, and in northern Idaho. Jenkin is grown from both fall and spring sowing. The acreage in southeastern Washington and Umatilla County, Oreg., has been largely replaced by Federation in recent years.

Jenkin is adapted to irrigated lands in the Yakima Valley of Washington and to the subhumid and cooler sections of southeastern Washington, northwestern Idaho, and the Willamette Valley of Oregon.

It produces high yields under the conditions existing in these districts whether sown in the fall or in the spring. Under less favorable conditions Jenkin has been replaced as a winter wheat by Hybrid 128 or Turkey, the latter a hard red winter wheat. When Jenkin is spring sown it is often injured by frost, drought, or hot winds because of its late maturity. It is an excellent hay wheat because of its tall, rank growth.

Hood, a selection from Jenkin, has slightly longer heads, taller straw, and is somewhat more winter hardy, and has been developed by the Oregon Agricultural Experiment Station. It was distributed in western Oregon in the fall of 1930.

REDCHAFF

Redchaff (Red Chaff or Oregon Red Chaff) differs from Jenkin in being shorter and earlier and in having heads more club-shaped and with lighter brown chaff (fig. 6, B). Although it is a spring wheat, Redchaff often is fall sown. It is rather tall and late.

The origin of Redchaff is undetermined. It was an important variety in sections of the Columbia Basin of Oregon and Washington from 1907 to 1920, and perhaps for many years earlier. In 1929 it was grown on only 8,000 acres in Oregon, Washington, Nevada, and Utah.

Redchaff is adapted to about the same conditions as Jenkin, but, being slightly shorter and earlier, can be more successfully grown in somewhat drier localities or on poorer soils. It has not produced very high yields in comparative experiments, and its cultivation probably should be discontinued.

BLUECHAFF

Bluechaff (Blue Chaff Calvert Club) differs from Redchaff in having a distinct bluish powder or bloom on the chaff and is somewhat later than Redchaff. Bluechaff was originated from a plant found in a field of wheat by A. C. Calvert, of Junction City, Oreg., in 1897. From this plant, which had seven heads, the variety was increased until 1904, when it was first distributed in the upper Willamette Valley of Oregon. It is now grown only on a small acreage in southwestern Oregon.

Little is known about the yields or milling quality of Bluechaff as compared with those of other varieties grown in the same sections. Jenkin and several varieties of common wheat are more promising than Bluechaff in western Oregon.

GROUP 4.—HEADS BEARDLESS; CHAFF VELVETY, WHITE OR YELLOW; KERNELS RED

Coppei is the only variety in group 4 that is grown commercially.

COPPEI

Coppei (Coppei Club) is easily distinguished from most other club wheats by its velvety chaff. It is a winter wheat, but if spring sown will mature late in the season. The variety was originated from a plant found in 1907 by J. L. Harper, of Waitsburg, Wash., in a field of Little Club near Coppei Creek, 3 miles south of Waitsburg.

It was grown and increased until 1911, when it was first distributed. Its appearance indicates that Coppei may be the result of a natural cross between Little Club and Jones Fife, the latter being a soft red winter common wheat having velvety chaff.

Coppei was reported in 1929 only from Whitman and Spokane Counties in southeastern Washington, where about 3,000 acres were grown. Since 1929 its acreage has decreased.

It yields nearly as well as Hybrid 128, but it generally has a lower market value and is graded in the subclass (*b*) western red under the official grain standards.

GROUP 5.—HEADS BEARDED; CHAFF SMOOTH, BROWN OR RED; KERNELS RED

Group 5 is represented by a single variety, Mayview, which is bearded.

MAYVIEW

Mayview has bearded, club-shaped heads with smooth brown chaff and soft red kernels. The stems usually are white or yellow at maturity, but may show a trace of purple on the lower joints. The plants are late and of medium height. It is a spring wheat but usually is grown from fall sowing.

This variety was originated from a selection found in a field of Goldcoin or Fortyfold wheat near May View, Wash., about 1911 or 1912. It was named Mayview by E. F. Gaines, cerealist of the Washington Agricultural Experiment Station in 1917, when he first observed commercial fields of the variety in Washington.

The variety probably originated as a result of a natural field cross between a club variety and a bearded variety of common wheat. Wheat plants similar to Mayview have been found as mixtures in fields in Idaho and Montana.

For a few years Mayview was grown on a large acreage in the vicinity of its place of origin, but because of its bearded heads it did not become popular. It has yielded less than Hybrid 128, and apparently has largely disappeared from cultivation.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1709

POCKET-GOPHER CONTROL

1862 1889

THE POCKET GOPHERS constitute a family (Geomyidae) of the native rodents of the United States. They are called pocket gophers because they are not only burrowers (" gophers ") but also have cheek pouches in which to convey roots and other food for storage in underground chambers. In areas where these rodents are not of economic significance they should not be destroyed.

In cultivated fields, grazing ranges, forest plantations, orchards, parks, airports, and elsewhere, however, pocket gophers become important pests. In such areas, even a few are capable of serious damage, and their control is necessary. Their destructiveness consists not only in cutting roots of cultivated crops, fruit trees, and forest growth but in smothering vegetation with mounds of earth. By burrowing into embankments of water reservoirs and irrigation canals they cause costly breaks and the loss of much water. Their burrows interfere with the proper distribution of water used in irrigation and contribute to soil erosion.

Measures of control, therefore, are necessary, but because of the differing tastes and habits of the more than 100 varieties some methods that are found satisfactory in one region have no controlling effect in others. The practices here recommended are based on studies of these varying habits of pocket gophers and of environmental conditions, and are applicable wherever these rodents are found.

Washington, D.C. September 1933

POCKET-GOPHER CONTROL

By W. E. Crouch, *senior biologist, Division of Predatory Animal and Rodent Control, Bureau of Biological Survey*

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INTRODUCTION

WITHIN THE BORDERS of the United States are found more than 100 named and described varieties of pocket gophers, in the three genera *Geomys*, *Thomomys*, and *Cratogeomys*. These rodents occur throughout the greater part of every State west of the Mississippi River and eastward over most of Illinois, southern Wisconsin, northwestern Indiana, and also in large areas in Alabama, Georgia, and Florida (fig. 1).

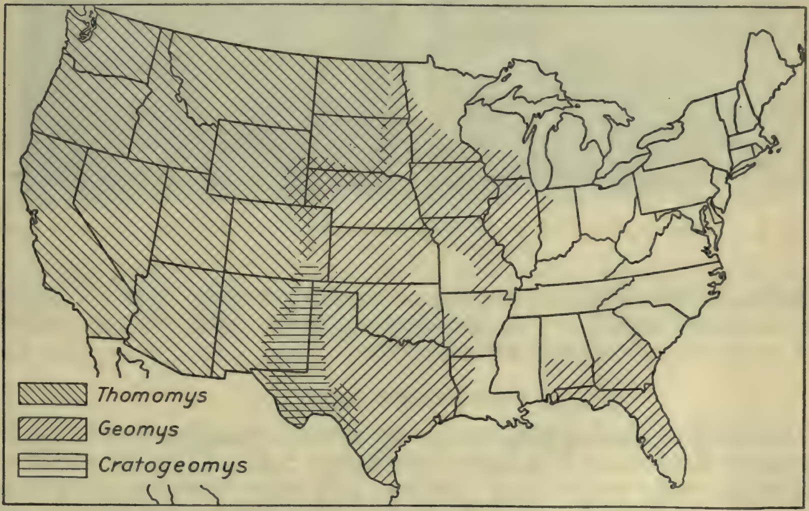

Figure 1.—Distribution of pocket gophers in the United States—ranges of species of *Thomomys* (west) and *Geomys* (east) overlap in a strip from Texas to the Dakotas, except where separated by *Cratogeomys* in parts of Texas, New Mexico, and Colorado.

NAME AND STRUCTURE

The pocket gopher is locally called salamander, pouched rat, camas rat, or merely gopher. The term "gopher" is applied also to various species of ground squirrel, and the same name is used for a burrowing land turtle, particularly in Florida. In some localities moles also are called gophers.

The true pocket gopher (fig. 2, A) is easily distinguished from the other animals to which the name of gopher is applied. It derives its name from its most outstanding characters—it is a burrowing animal and has large cheek pockets. These pockets are wholly outside the mouth (fig. 2, B), are lined with fine hair, and are used to convey food and nesting material. The pocket gopher carries on its activities mainly underground and is seldom seen on the surface by the casual observer, though there is unmistakable evidence of its activities aboveground.

The stocky body is heavy in the forward part and well built to support muscles for digging. The shoulders and arms are strong, and the hands are equipped with long, sharp claws. The body hair, although not true fur, is soft and glossy. The tail is short and scantily haired, the ears are inconspicuous, and the eyes are small. The 2 upper and 2 lower incisors, or front teeth, are prominent and protrude outside the mouth cavity.

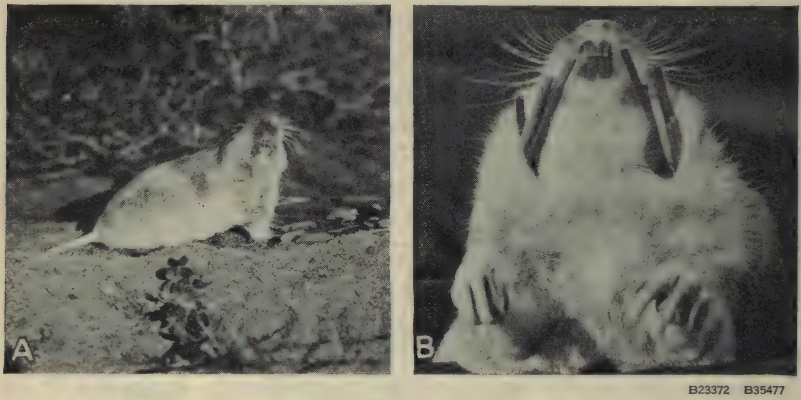

FIGURE 2.—Pocket gophers: A, Live animal aboveground; B, near view, showing cheek pouches filled with roots.

COLOR AND SIZE

The color of pocket gophers varies greatly, ranging from a light brown or fawn color to a dark chocolate or black. The shade differs somewhat with species and locality, and some varieties may have two or more color phases. Melanistic individuals are found, and one species, inhabiting the Oregon coastal area, is entirely black. White, or albinistic, individuals also are found, though rarely.

In general pocket gophers are much larger than field mice, and those of most species are larger than moles. There is great variation in size, the several species ranging in weight from about 4 to 18 ounces and in total length from 6 to 13 inches. In each species, however, the size is fairly uniform. The usual individual variation is noted in young animals, and generally a marked difference in size between males and females, the males being the larger.

ADAPTABILITY

Pocket gophers readily adapt themselves to changed conditions brought about by agricultural and other developments, and within their range agriculture has favored their increase and their possibilities for damage. Such crops as alfalfa and clover furnish them excellent food and harborage, since these crops are generally grown on the same land for a period of years. The extensive reclaiming of arid lands has been especially favorable to the pocket gophers. All these changes have resulted in a great increase in the numbers of these rodents in many agricultural sections, and consequently have intensified their destructiveness (fig. 3) and made control measures necessary.

The claim has been made, probably with some merit, that pocket gophers serve a useful purpose because their extensive burrowing aerates and drains the soil and also fertilizes it by mixing in the vegetation. This, however, is an unimportant consideration where land is under cultivation. On such an area a plow accomplishes the same end without injuring garden, field, lawn, or park.

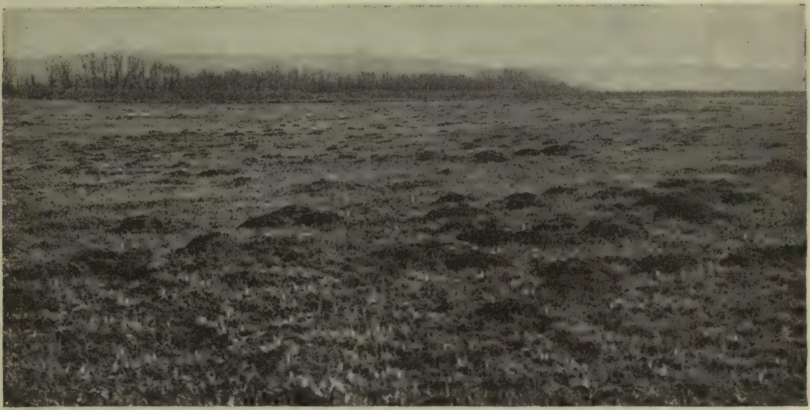

FIGURE 3.—Pocket-gopher mounds in alfalfa field. B13934

NEED FOR CONTROL

It is chiefly through burrowing activities that pocket gophers become injurious, although in certain situations their feeding habits are also destructive to plant life. In places where their operations have no ill effects, these rodents should not be molested, as they are interesting members of the native fauna. On range areas the control of pocket gophers should be undertaken only where these rodents are so numerous as to destroy forage needed for other animals or where their burrows are a serious contributing cause of soil erosion. The varied destructive activities of pocket gophers and the losses caused thereby may be summarized as follows:

In digging burrows pocket gophers destroy plants in fields (fig. 4, A), gardens, meadows, pastures, lawns (fig. 4, B), and parks, and cover much of the growing vegetation with soil.

They cause loss of hay by throwing up mounds, which prevent close mowing and injure machinery.

They ridge the soil and denude it of vegetation, thus being a contributing cause to beginnings of soil waste by destructive erosion (fig. 5).

They destroy many fruit, nut, and forest trees by gnawing the roots.

They eat growing grain and other crops.

Palms introduced into the southern part of the United States are subject to damage by pocket gophers, the rodents not only feeding upon the roots but hollowing out the base of the trunk or tunneling spirally upward through it and making chambers in its soft interior (fig. 6).

By burrowing into reservoirs in arid sections they cause considerable waste of valuable water needed for livestock.

Their burrows admit water used in irrigation, thus interfering with its proper distribution as well as helping it wash out deep gullies on sloping land (fig. 8).

By burrowing into dams and embankments of irrigation canals they cause costly breaks and the loss of much water (fig. 7).

Pocket-gopher damage in other places includes injury to aviation fields, where the burrows and mounds become a hazard to airplane landing; burrowing in cemeteries; and interference on golf courses, particularly by raising mounds on greens and fairways.

The control of pocket gophers on irrigated areas is as important in the distribution of the water as is the leveling of the land; it is particularly important where new irrigation projects are being established. To cut down maintenance costs it would be well to eradicate this rodent from an area before water is turned on to the land and to use all means possible to keep the project free from the rodents at all times. It is also important that the animals be eliminated from areas that are being planted for reforestation.

CONTROL IN RELATION TO HABITS

Because of the wide distribution of the many races of the pocket gopher there is considerable variation in the habits of the several species, and even in those of a single species in different localities. These habits have a direct bearing on control operations, and thus the complexity of the control problem is evident. This bulletin attempts to point out these differences in habits and to describe the various control methods that have been developed to meet adequately most situations.

BURROWING HABITS

Control of pocket gophers is especially difficult because of the extent and varying depth of their burrows (fig. 9). It is not uncommon for one pocket gopher to cover an acre or more of ground with its mounds. Many single systems of runways extend more than 800 feet. These large tunnel systems are not always connected, though in many instances they are continuous.

Pocket gophers usually burrow from 4 to 8 inches below the surface, but in some localities and at certain seasons they may go to a depth of 6 feet. In the more arid and warmer sections the depth of the burrow varies with temperature of the soil. During the cooler months the tunneling is much closer to the surface than in summer. In digging the deeper tunnels the rodent may place the excavated dirt in the tunnels of a higher level. Recognition of this habit has a direct bearing on control, as there are times of the year when activity is not apparent, there being no fresh mounds on the surface. At such times a person may be led to believe that his

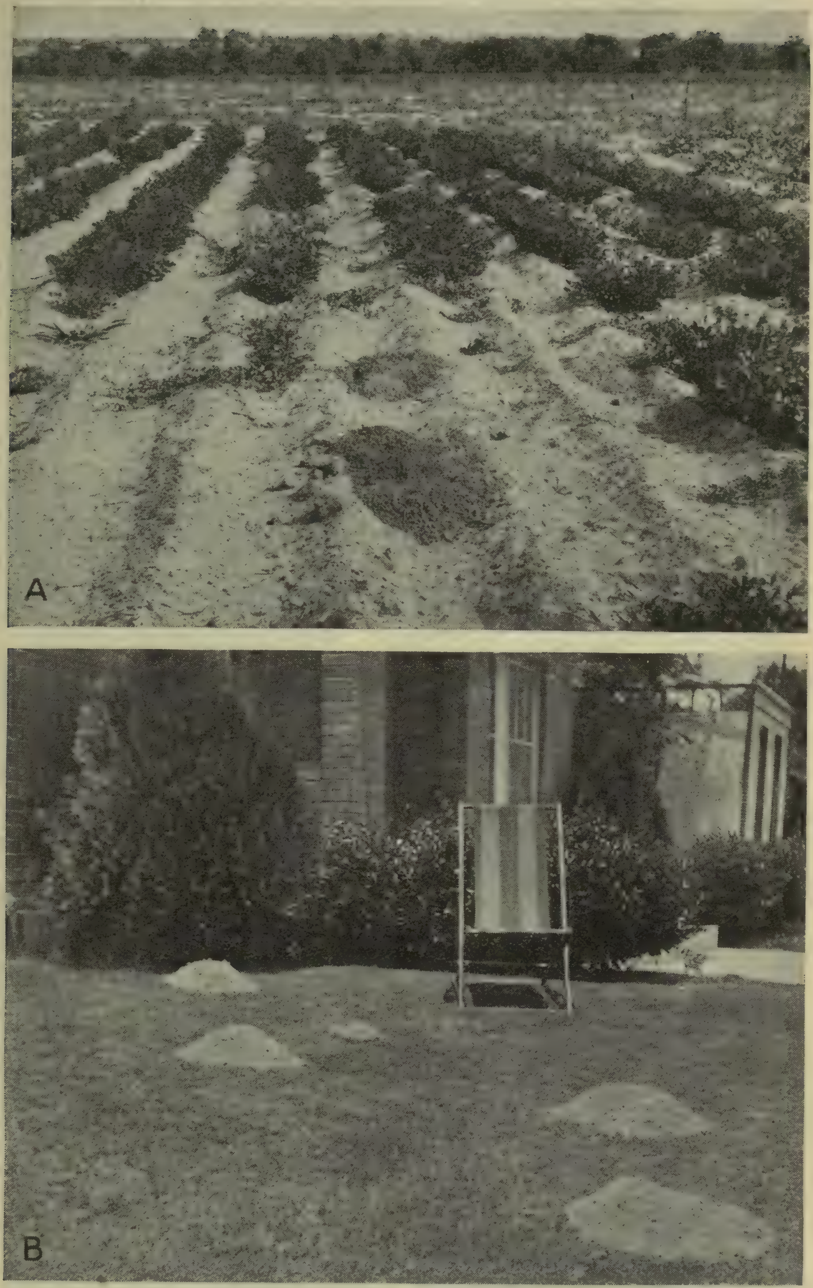

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FIGURE 4.—A, Peanut field damaged by pocket gophers; B, lawn disfigured and grass killed by pocket-gopher mounds.

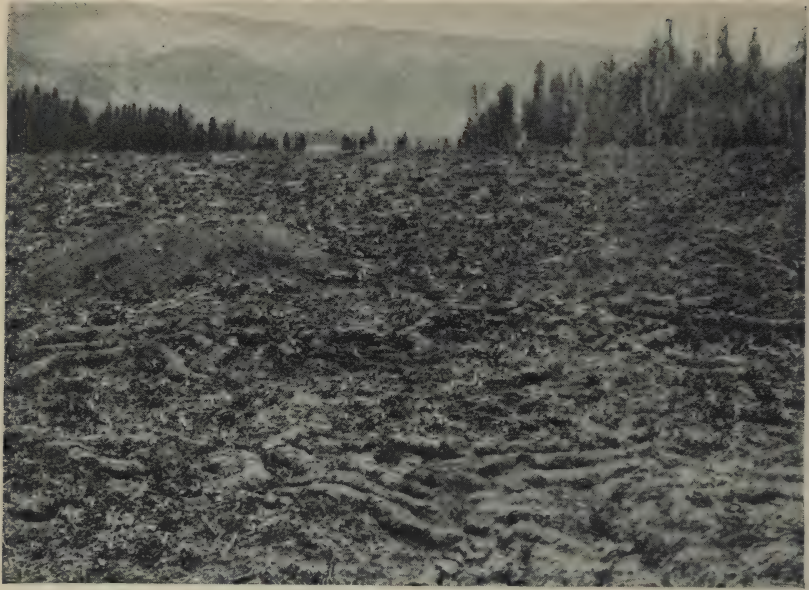

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FIGURE 5.—Earth forms left on the surface from pocket-gopher tunneling in the snow—a beginning cause of wasteful soil erosion during spring in most regions thus affected but at any season in mountainous country.

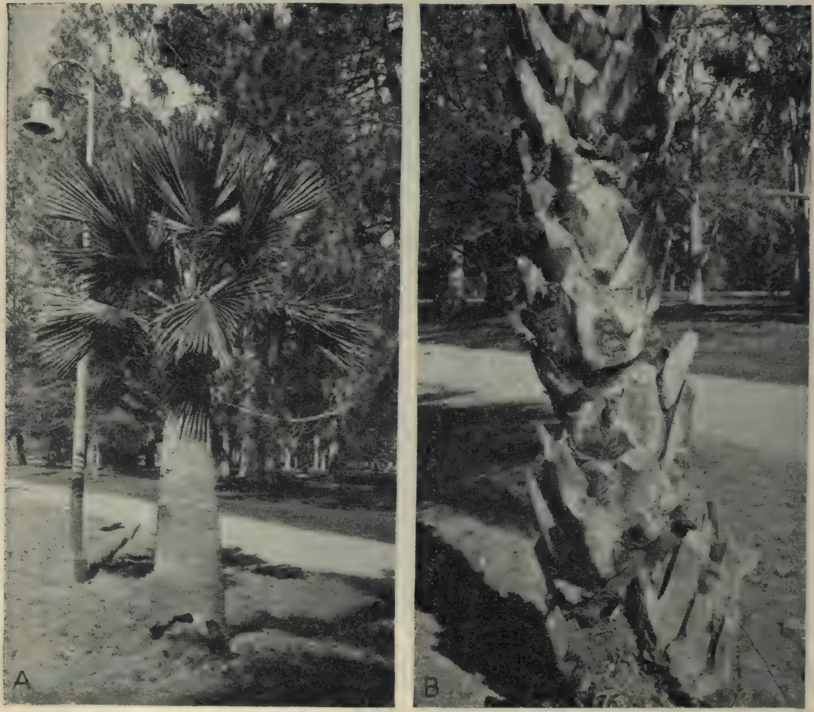

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FIGURE 6.—A, Palm tree, with pocket-gopher tunnel in trunk exposed; B, palm, with old leaf bases removed to show interior damage by the spiral tunnel.

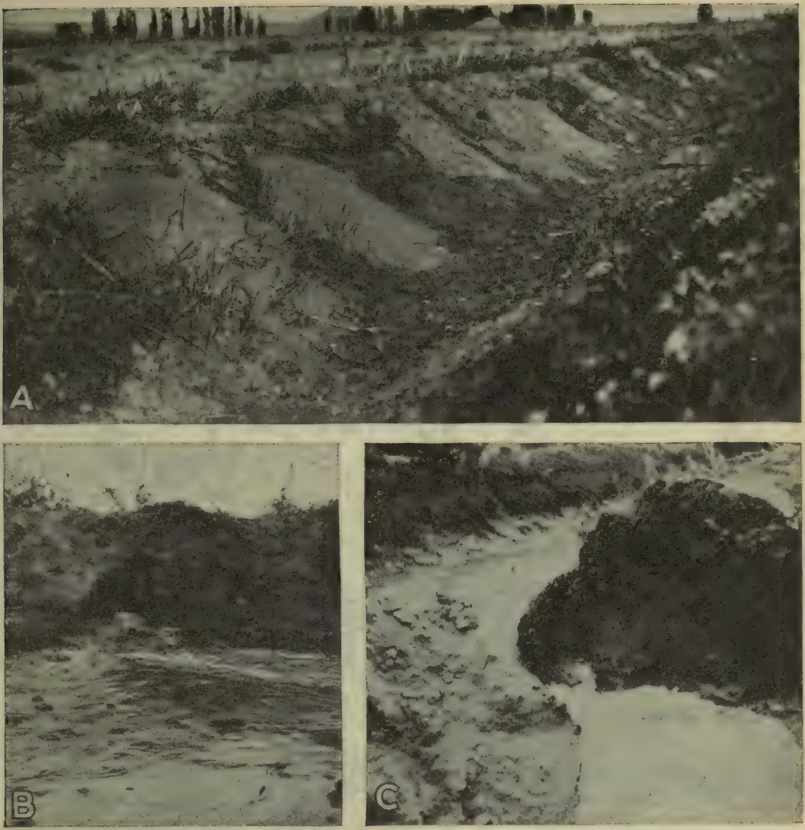

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Figure 7.—A, Pocket-gopher workings in dry irrigation canal; B, water escaping from ditch through one of the burrows after it was turned into the canal; C, costly break in bank started by water escaping through pocket-gopher tunnel.

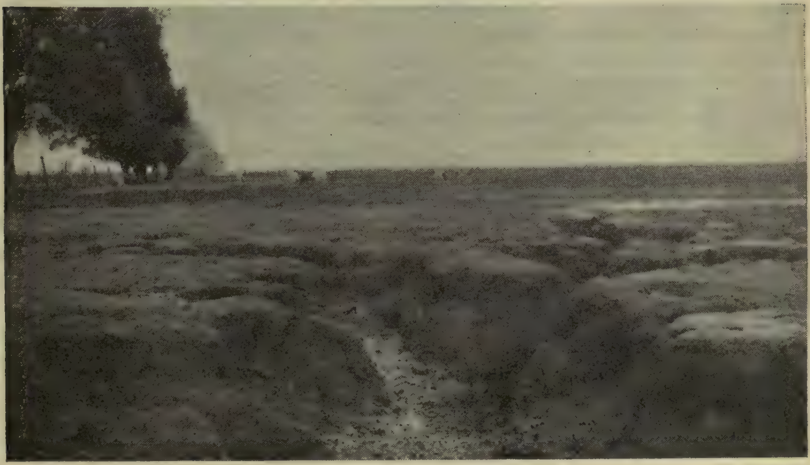

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Figure 8.—Damage to pasture land from erosion started by irrigation water coursing through pocket-gopher burrow.

control operations have eradicated all these rodents. In placing poisoned bait he is often deceived into thinking that an active burrow has been located when the probe strikes only a loosely filled tunnel.

ACTIVE SEASONS

Generally speaking, the pocket gopher is most active at periods when the ground is not frozen very deep, or when it is not very dry, hot, and baked. In most localities the period of greatest activity is in fall, but in the Southwest this period extends from the latter part of September to the last of May. Another active period, particularly in the northern part of the United States, is during a short time in spring. The best success in control is attained during these periods of activity.

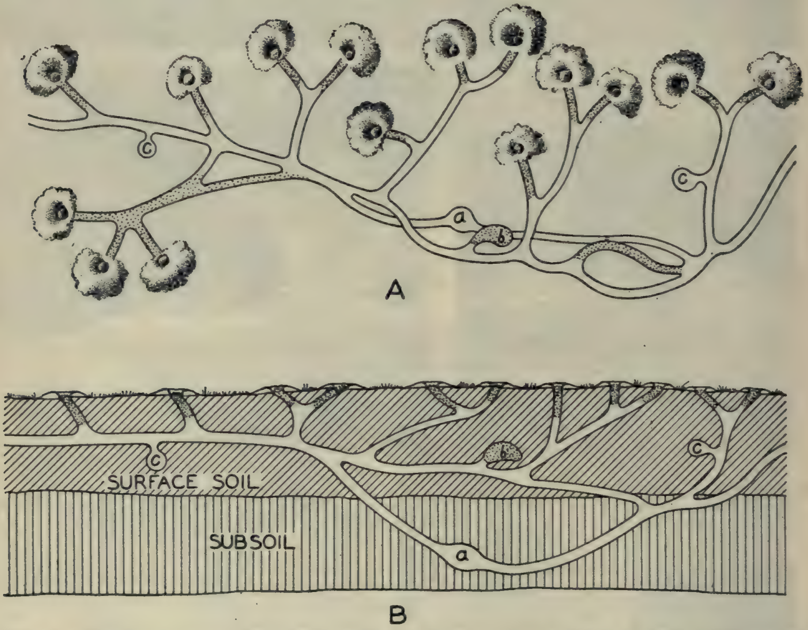

FIGURE 9.—Runway system of pocket gopher: A, Seen from above, shaded portions filled with excavated dirt; B, vertical cross section—*a*, used nest; *b*, old nest filled with dirt; *c*, store chambers for roots and other materials.

FEEDING HABITS

The food of pocket gophers is as varied as the plant life within their habitat. It consists chiefly of the roots, tubers, bulbs, and stems of plants (fig. 10), but includes also the leaves of forage plants, and small fruits and grains. The feeding habits have a direct bearing on control methods, particularly where poison is used. The most acceptable poison baits will usually be those made of food items to which the animal is accustomed. Roots and succulent green vegetation are favorites, and because of this, baits made of tuberous or root crops or of alfalfa, clover, or other fresh green vegetation are generally acceptable. The rodents obtain most of their food underground, but it is not uncommon for them to feed on the surface, particularly in the Southwestern States. The general habit of underground feeding makes it necessary to place poisoned baits and traps in the burrows rather than on the surface.

SOCIAL HABITS

Ordinarily, except during the breeding season or when the young are being reared, a burrow will be occupied by only one animal. This is particularly the case where burrows are widely scattered and distinctly separate. Hence, in general, the destruction of a single individual in each burrow, except at breeding time or when the young are being raised, will be all that is necessary to bring about adequate control. This is not always the case, however, for often several systems of burrows are connected, and therefore this rule cannot always be applied, particularly in the Southwest, where there is a long breeding season, or on areas where there is much tunneling. Where extensive burrows are close together the tunnels may be directly connected. In such a case it is not unusual to trap or poison several individuals in the same burrow.

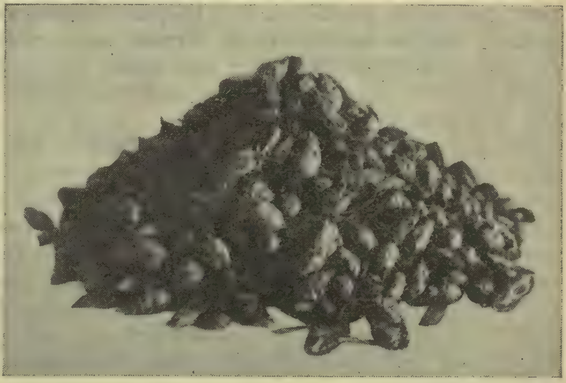
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FIGURE 10.—Bulbs, tubers, and roots taken from a pocket-gopher store chamber.

METHODS OF CONTROL

The most common methods employed in destroying pocket gophers are poisoning, trapping, flooding, fumigating, and shooting. To accomplish adequate control a combination of two or more of these methods is often necessary.

The most practical and efficient methods are poisoning and trapping. Where control is desired over a large area in which the rodents are numerous either poisoning or a combination of poisoning and trapping should be employed. On small areas or on large tracts where there is only a small number of the rodents the use of traps alone is probably the most satisfactory method. The determination of the most efficient method to employ and the best season of the year in which to work will depend on the species of pocket gopher concerned, the degree of its activity, the locality, and the local agricultural practices.

Control operations can best be conducted during parts of the year when the pocket gophers are active, and this is usually indicated by the presence of fresh mounds of dirt. At times of less activity much time and material may be wasted in treating unoccupied systems of runways. During fall, the season when pocket gophers are usually most active, control operations can be carried on with the least interference to growing crops, and then also the runways are more easily located. The suitability of the different methods of control under varying conditions will be treated in the discussion of these methods.

POISONING

On extensive areas heavily infested with pocket gophers poisoning is probably the least expensive and the most easily applied method of control. In many cases it is also the most effective. The danger of destroying useful birds and animals is small, since the poison baits are placed in the underground runways through openings that afterwards are closed.

The baits most commonly used are sections of sweetpotatoes, carrots, parsnips, potatoes, turnips, and beets, and their acceptability is usually in the order named. Grain baits of wheat and oats are readily taken in some localities and green baits of fresh clover or alfalfa leaves should be used in some sections of the country, particularly in the Northwest.

Pocket gophers vary in their tastes, and all individuals in the same locality may not accept the same bait. In such cases it may be necessary to re-treat an infested area, using some other material for bait. A good plan is to use sweetpotatoes for the first treatment and carrots for the second; and if necessary a third bait of grain might be exposed. In all three treatments it is necessary to bait only the runways in which there are fresh mounds. To use a mixture of several baits at one time requires a killing dose of each, and this is more expensive and less effective than to make 2 or 3 treatments with different baits.

The vegetables for baits should be thoroughly cleaned and then cut into pieces about half an inch square and 1½ inches long. Baits 1 inch long are satisfactory for the smaller species. Some workers cut the vegetables in cubes, but, in the experience of many, better results are obtained by cutting them in long pieces. The purpose is to defeat the pocket gopher's frequent habit of storing food before eating it, and thus to insure that the poison be taken immediately. Baits cut into longer pieces are more likely to be consumed when found than they are to be stored. This has been clearly demonstrated in several experiments.

The following formulas for poisoned baits for pocket gophers are recommended:

Formula No. 1.—Root Baits

Cut into pieces 1½ inches long and ½ inch square	2 quarts sweetpotatoes or carrots.
Dust over these from a sifter (pepper box), while stirring	⅛ ounce strychnine alkaloid (powdered).
Mix thoroughly.	
In southern Arizona and in a few other localities, this formula is modified by using 4 quarts of the bait to ⅛ ounce of the strychnine alkaloid.	

Formula No. 2.—Leaf Baits

Gather fresh from field, free from dew, rain, or other moisture	1¼ pounds green clover or alfalfa leaves.
Keep free from dirt and other foreign materials.	
Spread on heavy paper or put into a tight box or washtub.	
Dust over these, from a sifter (pepper box), while stirring	⅛ ounce strychnine alkaloid (powdered).
No more should be prepared than can be used in 1 day.	

Formula No. 3.—Grain Baits

Mix well	¾ pint water
and	⅖ ounce laundry starch.
Bring to a boil while stirring constantly.	
Cook until a paste free of lumps is obtained.	
Stir into the paste	¼ pint corn sirup
and then	½ ounce glycerine.
Mix in a 1-gallon container	1 ounce strychnine alkaloid (powdered)
and	1 ounce baking soda.
Pour the hot paste over this mixture while stirring thoroughly.	
Pour the whole mixture over	16 quarts wheat (plump kernels), or steam-rolled oats.
Stir until kernels are well coated, and then spread out to dry.	

Pocket gophers of the genus *Thomomys*, found in the western half of the United States, can generally be successfully poisoned by use of the root-bait formula (no. 1). The large Willamette pocket gopher (*T. b. bulbivorus*) in the Willamette Valley, Oreg., however, is an exception; to poison it, it is necessary to use the leaf-bait formula (no. 2) with clover leaves for bait material. For the large Townsend's pocket gopher (*T. towsendi*) in the Snake River and Boise Valleys in southern Idaho formula no. 1, or formula no. 2 with alfalfa leaves, may be used.

The large pocket gophers inhabiting the prairie States (*Geomys bursarius*) have shown a preference for grain baits, wheat being the one most generally accepted. In some areas it has been found that during the hot months of July and August steamed-rolled oats are preferred to wheat. The grain-bait formula (no. 3) may be used for this species.

LOCATING RUNWAYS

Effective methods of locating runways and placing the baits are (1) the use of a probe (fig. 11), and (2) the use of a strong garden trowel (fig. 12), shovel, or other implement made especially for the purpose. The probe method is the simpler and offers a quicker way of distributing the poison, but it does not always insure right placement. In the hands of an experienced person, however, the probe may prove as effective as the trowel.

For limited use in light sandy soil, or any soil that is not too hard, a satisfactory probe can be made of a broom, fork, or shovel handle, as shown in figure 11, A and B. One end should be bluntly pointed, and a foot rest may be attached to aid in probing. For use in hard soil, an iron rod may be inserted at one end, as illustrated in figure 11, A, to be used as a seeker, the handle being bluntly pointed for enlarging the opening through which the bait is to be placed.

For extensive use in relatively soft soil a durable probe may be made of ¾-inch galvanized pipe—1 piece 30 inches long, 1 piece 14 inches long, and 3 pieces each 5 inches long. The 30-inch piece is threaded at both ends and the other pieces at one end only. A piece of ½-inch round iron about 2 inches long is welded into the unthreaded end of the 14-inch pipe and bluntly pointed. The pieces are then arranged and fitted together with two ¾-inch **T**-joints, as shown in figure 11, C.

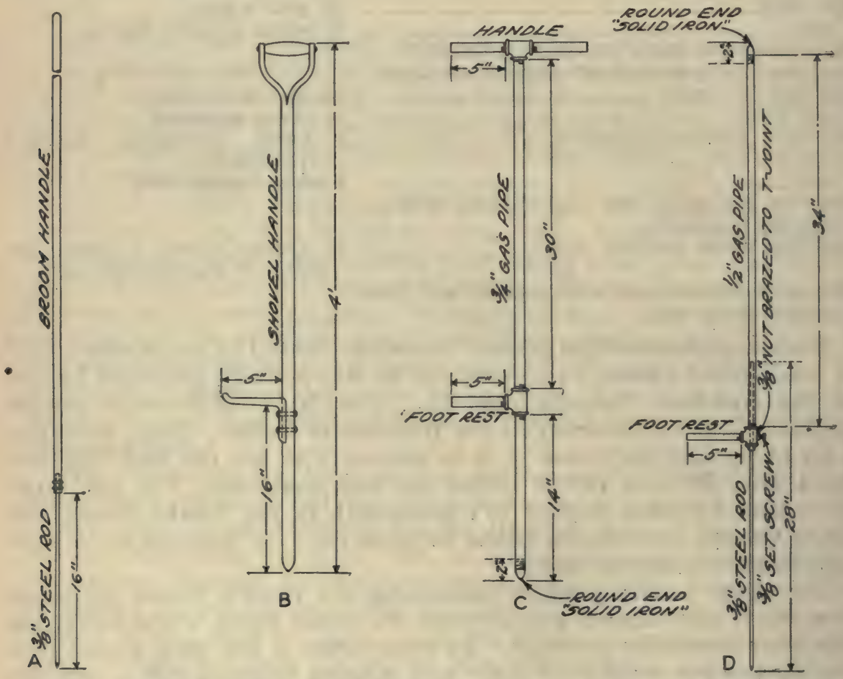

FIGURE 11.—Types of runway probes commonly used to reach burrows when trapping or poisoning pocket gophers: A, Made from broom handle and steel rod; B, from shovel handle; C, from gas pipe, for use in soft soil; D, from gas pipe with steel rod, for use in hard soil.

For use in hard soil the probe may be made of the following materials:

1 piece of ½-inch galvanized pipe, 34 inches long
1 piece of ½-inch galvanized pipe, 5 inches long
1 ½-inch galvanized **T**-joint
1 piece of ½-inch round iron 2 inches long
1 piece of highly tempered steel, ⅜ inch in diameter and 28 inches long
1 ⅜-inch set screw, 1 inch long
1 ⅜-inch nut
1 reducer, ½ inch to ⅜ inch

The two pieces of pipe are each threaded at one end. The piece of round iron is welded into the unthreaded end of the 34-inch pipe and bluntly pointed. A ⅜-inch hole is bored in the T joint, and the ⅜-inch nut is brazed over this hole to accommodate the set screw. The piece of highly tempered steel is sharply pointed on one or both ends and held in place by the set screw. The pointed end of a hay-rake tooth cut 28 inches long would serve well for this piece. These materials are then assembled as shown in figure 11, D. The runway is located with the sharp end of the probe, and the blunt end of the probe is used to enlarge the hole to admit the poisoned bait.

In locating the runways with a trowel (fig. 12), shovel, or special implement, there can be no question as to whether the baits are placed in a clean, used main runway, but this method requires considerably more labor and time.

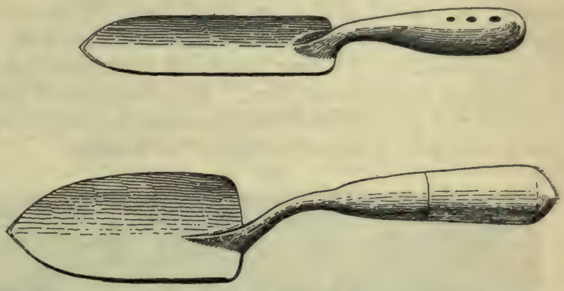
Figure 12.—Strong garden trowels for excavating pocket-gopher burrows in trapping and poisoning operations.

The location of the main runways, as viewed from the surface of the ground, may be determined in different ways. The common practice is to probe between two fresh mounds, it being taken for granted that the runway has a direct connection with the mounds. Sometimes this is the case, but not often, for the mounds are built at the mouth of the laterals and the main runways extend back from the mounds, in some cases a comparatively long distance. Often the main runway runs in divers directions.

Another effective method, particularly after a person has had considerable experience, is to determine the main runway from the shape of the mound (fig. 13). The mound is generally somewhat semicircular or fan shaped, and usually the main runway can be located at a point between 8 and 18 inches from the flat side. Therefore, if one probes within about 18 inches from this side, as indicated in figure 13, he will usually locate the main runway in not more than two trials. On the steep sides of hills, ditches, roads, and the like, the burrows generally can be located at an elevation slightly higher than the mounds. When a trowel instead of a probe is employed, the same method can be

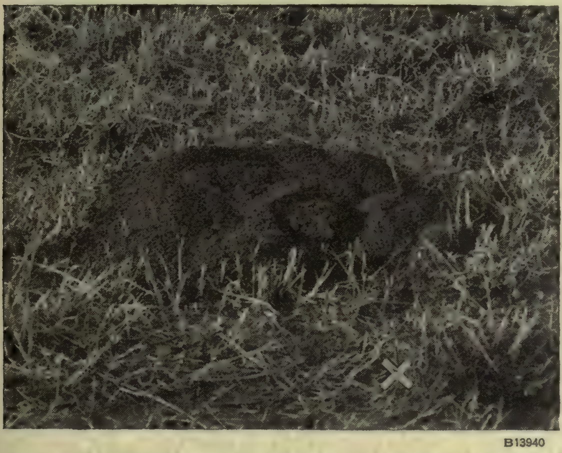

Figure 13.—Shape of pocket-gopher indicates where to probe for the main runway (marked X).

followed, but the result is different, in that when located there is no doubt whether it is the main runway. This is not always the case when a probe is used.

PLACING BAITS

After the runway is located, the bait, consisting of 2 or 3 pieces of the poisoned vegetable, a level tablespoonful of the poisoned grain, or a small handful of the poisoned green clover or alfalfa leaves, is placed in the runway through the opening (fig. 14). When the bait has been put in the runway, the hole is covered with vegetation, hard dirt, or some material that will not crumble. This in turn is covered with loose dirt. It is not good practice to use loose dirt first in covering the hole, because it may fall into the runway and cover the bait and thus render it useless.

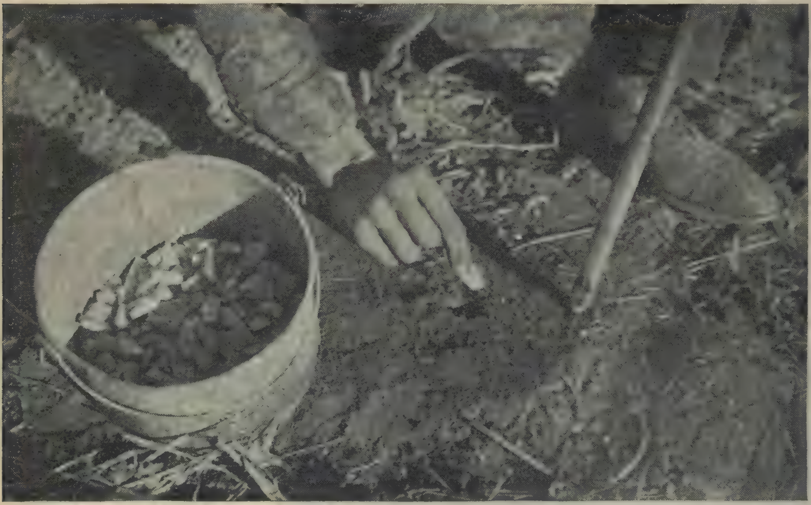
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FIGURE 14.—Dropping bait in pocket-gopher runway, through hole made with probe.

When a probe is used, care should be exercised not to make a deep depression in the floor of the runway (as illustrated in figure 15, B) because baits will drop into it and thus will not be readily found by the pocket gopher.

Each system of runways should be baited at two or more places to insure a correct placement of bait and to increase the chances that the rodent will come in contact with it. The more extensive systems should be baited at several points. It is well to level all the fresh mounds with a rake or drag a few days after poisoning, for if any pocket gophers have escaped, their fresh workings can then be readily detected. One cannot expect to destroy all the rodents with a single poisoning, and often it is well to give the infested area two or more treatments.

The success attained in poisoning depends largely on cleanliness in handling the baits and care and accuracy in distributing them. It is important that the baits be placed in a clean, used main runway;

otherwise the rodent is not likely to come in contact with them while they are acceptable. It is desirable to use fresh poisoned baits, particularly those made of roots and green leaves, as stale baits are not acceptable to pocket gophers. It is easy to place baits improperly, especially when the probe method is used. The pocket gopher's habit of filling unused runways with comparatively loose dirt contributes to this end, because the operator probing into one of these loosely filled runways receives the impression that it is the used runway. Bait placed at this point would in all probability not be visited by the rodent for some time, and perhaps not at all. Often an operator will mistake a lateral or side runway for the main runway. Baits placed in these laterals would not be effective because such runways are used chiefly for carrying dirt to the surface.

Often someone asks how to distinguish the main runway from the side runways or laterals. To answer is rather difficult, and only an experienced person can readily note the difference. If a runway is discovered 18 inches or more from the mound, however, in all probability it may be rightly considered the main one, since the laterals are usually not more than 18 inches long.

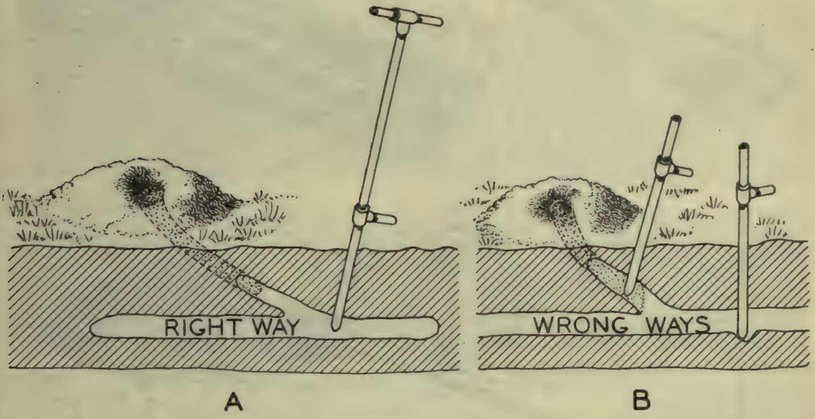

FIGURE 15.—A, Right way of using runway probe in pocket-gopher poisoning operations; B, wrong ways.

TRAPPING

Trapping is recommended for pocket-gopher control on small areas or on larger tracts with light infestations. Though slower and somewhat more expensive than poisoning, in many cases it is a surer method of ridding a farm of pocket gophers. There are several effective and inexpensive traps on the market. The types illustrated in figure 16, A and B, are adapted to most localities and have proved generally satisfactory. They are not so effective in areas inhabited by the larger species of pocket gopher, because the spread of the trap jaw is not wide enough. To take these, the type illustrated in figure 16, C, is probably the most satisfactory.

In comparison with the traps made specially for pocket gophers the common steel trap is too low in efficiency to justify its use.

In placing traps a freshly constructed mound should be selected and the burrow located nearby. The mounds are more or less fan-shaped, with the plugs of the laterals or side runways at the base. With a long-handled iron spoon or a strong garden trowel the lightly plugged opening of the lateral may be cleaned out and enlarged sufficiently to admit the trap. The setting may be in the lateral if this is long enough for the trap not to extend into the main runway, though many times it is advisable to set the traps in the main runways rather than in the laterals (fig. 17).

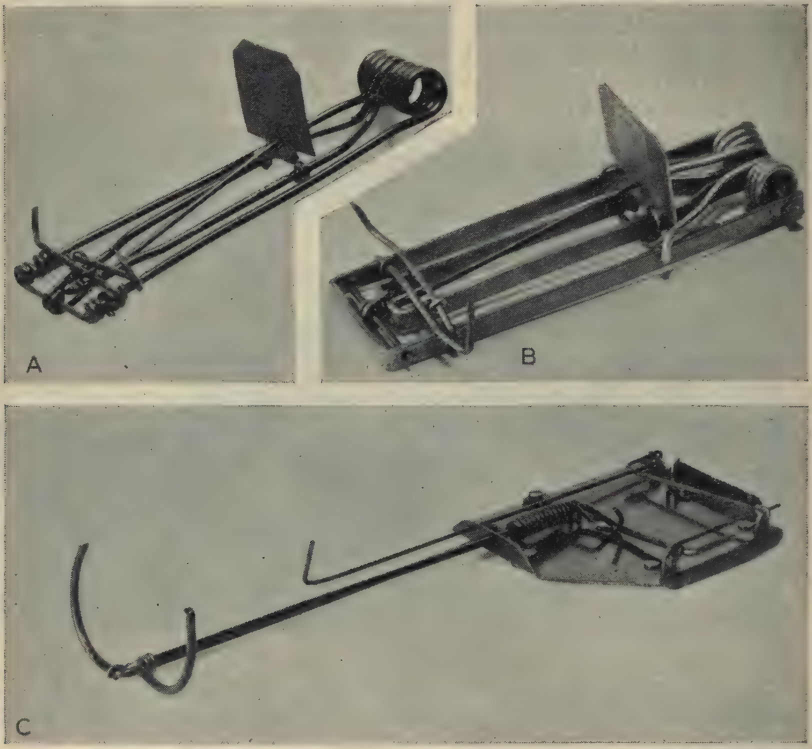

FIGURE 16.—Inexpensive types of pocket-gopher traps now on the market. A and B are generally satisfactory in most areas; C is best for trapping the larger species.

The main runway may be located with a probe, as described on page 13, or it may be found by digging out the lateral to its junction with the main runway. In a main runway two traps should be used, as shown in figure 17, one facing each way, so that a pocket gopher coming from either direction will be caught. (Pocket-gopher traps can be entered from only one direction.)

Traps in either a lateral or a main runway should be placed 12 to 18 inches back, and the burrow should be left open or only partly closed, as air and light bring the pocket gopher to repair the break. The trap is then sprung and the animal is caught. It is not necessary or advisable to bait the trap.

It is well to fasten the lighter traps to stakes, with a light wire or cord. A single strand of galvanized clothes-line wire is satisfactory because it does not rust and is pliable enough to keep the trap from being tilted in the setting. If the trap is not fastened, the captured pocket gopher may escape with the trap or some animal may carry away both rodent and trap.

In order to trap a given area systematically, it is well to mark each setting by attaching a piece of cloth to the stake, or a sharpened piece of ordinary lath may be used instead. Such marking shows when the area has been thoroughly covered and also makes it easy for the trapper to locate the traps and give them proper attention.

As in poisoning to rid an area of pocket gophers, it may be necessary to supplement trapping with some other method, since a few wary individuals may be difficult to trap. As a rule, poisoning will prove effective as a follow-up.

Since there may be in the burrows a considerable number of young too small to be caught in traps, it is sometimes advisable to place poisoned baits in the runways after removing the traps. Such procedure is particularly recommended in the Southwest, where the breeding season of the pocket gopher extends over a long period.

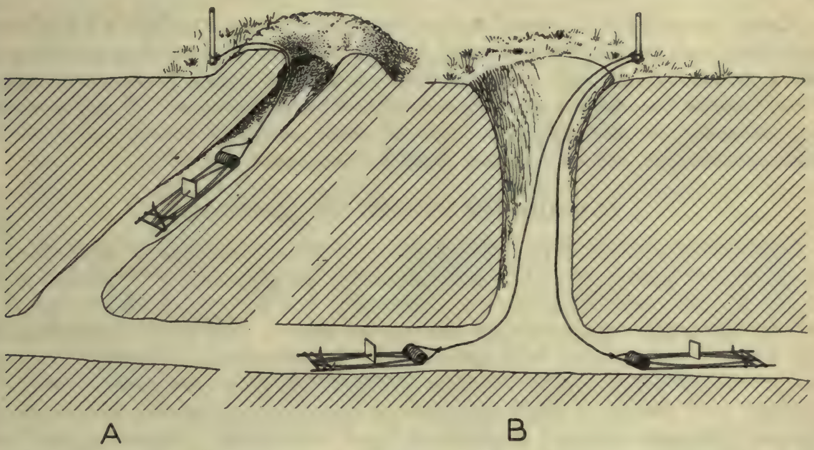

FIGURE 17.—Where to set traps for pocket gophers: A, In lateral, or side runway; B, in main runway.

FLOODING

In sections of the country where flooding of fields is an essential part of irrigation operations, it is sometimes possible to divert the water into pocket-gopher burrows, and thereby drive the rodents to the surface. There they can be promptly dispatched. A good dog can be trained for the purpose. Though not recommended as a generally effective method of control, flooding may be advantageously used in conjunction with irrigation operations.

FUMIGATION

Various fumigants have been tried for destroying pocket gophers, but in general they have not proved successful because the extensive and intricate burrow system does not permit adequate diffusion of the gases. Generally the burrows are close to the surface, and this permits easy escape of the gases through the soil. Furthermore, when the rodent detects the gas, it quickly plugs the runway with dirt and thus shuts it out. Fumigants that have been extensively tried out include carbon disulphide, fumes from burning sulphur, exhaust from an automobile, and calcium cyanide. It is only in such places as wet meadows, where the burrows are short and isolated, or in canal banks, where the burrows are short and comparatively straight, that any of these gases can be used effectively.

SHOOTING

Pocket gophers are occasionally seen aboveground early in the morning and about sundown. Then they can be killed with a shotgun. Opportunities occur so seldom, however, that this method of control is not to be seriously considered.

USE OF VIRUSES

Many so-called "viruses" have been put on the market with claims that they can be effectively used in the control of pocket gophers and other rodents. It has not yet been demonstrated, however, that a virus can be employed successfully for the destruction of any rodent, and because pocket gophers are of such solitary habits, success in their control by use of a virus would seem most doubtful.

COMMUNITY EFFORT IN CONTROL

Effective control of pocket gophers requires persistent and coordinated effort throughout the community. In general, any person may easily rid his own premises by intelligent use of poison and traps, but unless the entire community unites in active and close cooperation, the area thus cleared will eventually be reinfested from adjoining lands. Careful attention must be given to all infested lands—farmed, vacant, and public. This applies particularly to waste lands along fences, streams, public highways, and railroads. Such places are favorite haunts of the pocket gopher, because the soil is easily tunneled, succulent roots furnish food, and there is usually little disturbance from cultivation. It is from such areas that adjoining cleared premises are often reinfested.

BOUNTIES

Resort to the bounty system in an attempt to bring about the community control of pocket gophers is against sound public policy—it is conducive to fraud, and it is not thorough.

It is not difficult to perpetrate fraud in claiming bounty on pocket gophers. Some public officials to whom scalps or tails are presented for bounty may never have seen a pocket gopher, and it would be practically impossible for them to distinguish a dried and shriveled pocket-gopher scalp or tail from that of any other small animal. Dishonest persons have frequently made several "scalps" or "tails" from the skin of a single animal, and a county may pay bounties on presentation of scalps or tails of pocket gophers that have been taken on areas far removed from those legally included under the plan.

After claiming bounty on the rodents that are easily captured, it becomes unprofitable to take the remainder. Consequently, considerable numbers are left to reproduce and reinfest the territory, and thus this drain on the public treasury continues indefinitely. Experience in many States has fully demonstrated that bounties on pocket gophers rarely bring about the desired control and that the cost of maintaining the bounty system is out of all proportion to the benefits received.

ORGANIZED OPERATIONS

Farming communities usually contain considerable areas of agricultural land held by nonresidents, as well as vacant land the owners of which are not vitally interested in destroying agricultural pests. In some regions a law requiring extermination of injurious rodents on every farm is beneficial in that it insures the destruction of pocket gophers on infested lands and compels negligent landowners to do their share in the work. Such laws usually provide for the control of pests on the initiative of the governing board of a county or township, or on petition to the board by a specified number of landowners. The work of destroying rodent pests is generally left primarily to the landowner or lessee, but if he fails to do it within the time specified, properly authorized persons may enter upon his lands, destroy the rodents, and charge the cost to his land in the form of taxes.

In some instances the desired results are accomplished by arousing the interest of all landowners through publicity and demonstrations by rodent-control experts, and by making suitable poisons and traps readily available at a low price. In many cases, however, thorough and effective community control of pocket gophers is accomplished only by employing men specially trained for the purpose and fully acquainted with the application of control methods. This system of pocket-gopher control is not always agreeable to all the landowners in the community, as some are not familiar with the procedure and its benefits and may object to persons other than themselves doing the work on their lands. The success attained within the past few years, however, in rural-community organization in various agricultural activities, particularly in pest-control campaigns, has simplified the organization of cooperative rodent-control effort in most localities. If this should not be the case in a particular pocket-gopher-infested community, it will be advisable first to organize the community without employing specially trained men. The important thing is to bring about an appreciation of the necessity for systematic and coordinated effort. Such effort involving the entire community can be made only after the majority of landowners have requested it and have agreed to the plan.

The expenditure of funds necessary for coordinated operations should be made mainly by a single agency. This may be accomplished by the county board appropriating funds and collecting from each landowner payment in the form of taxes under the provisions of a compulsory rodent-control law for the actual cost of treating his land, or the board may finance the work from funds raised by a special tax levy, if authorized by law. Or the finances may be provided before the work is started by assessment on private lands on a prorated basis and collection of the fund from the landowner through some existing organization or one specially formed for the purpose.

The operations should be supervised by a person well qualified by experience and training in methods of rodent control and in the organization of control activities; otherwise many mistakes are likely to be made and the project may fail through inefficient organization. The control of any rodent pest must be undertaken in a systematic and businesslike manner. In a large area it cannot be obtained by haphazard, unorganized efforts.

For directing the organization and conduct of community pocket-gopher control, the aid of rodent-control representatives either of the Bureau of Biological Survey or of State or county agencies, including agricultural extension services, is frequently available. Any community contemplating organized control of pocket gophers would do well to consult the Biological Survey's local leader of rodent control if there is one conveniently stationed in the State.

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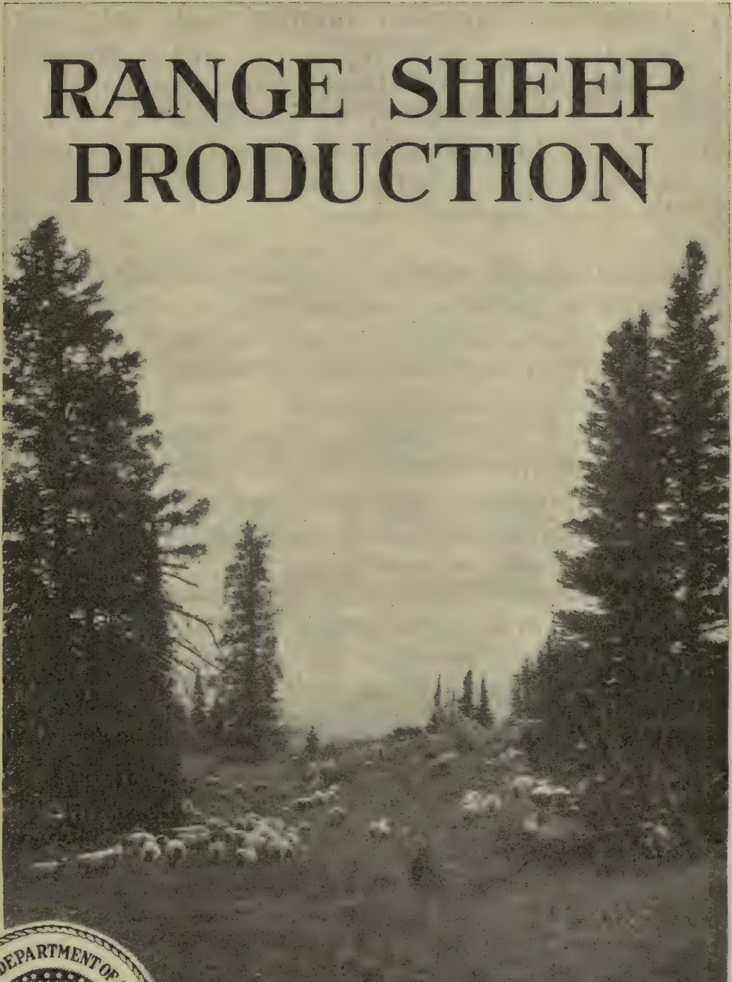
FARMERS' BULLETIN No. 1710

RANGE SHEEP PRODUCTION



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OWING to insufficient rainfall, rocky soil, and other causes, much of the area in the Western States is unsuitable for tillage but is well adapted for grazing. In this so-called "range area" an extensive sheep industry has developed; in fact, more than 60 percent of the sheep in the United States are in 11 Western States and Texas.

Successful range-sheep operations involve ability not only in selecting and breeding stock adapted to the various sections, but also in meeting many hazards and special problems. Although lambs have returned more profit than wool in recent years, the production of heavy fleeces of good wool is still an important source of revenue. Attention to the seasonal requirements of sheep and lambs for their most profitable development also materially influences the returns received.

This bulletin is based largely on experience and results with experimental flocks in the area mentioned. Its purpose is to meet the demand, from western sheepmen and others interested, for information on sound methods of range sheep production.

Washington, D.C. **Issued August 1933**

RANGE SHEEP PRODUCTION

By J. M. Cooper, *associate animal husbandman, Animal Husbandry Division, Bureau of Animal Industry*

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DEVELOPMENT OF THE RANGE SHEEP INDUSTRY

BECAUSE of shallow rocky soil, arid and often severely cold climate, rough topography, and a comparative lack of transportation facilities, much of the western range country is unsuited to crop farming and the support of dense populations. It is, therefore, probable that this region will continue to support large numbers of grazing animals. More than 60 percent of the sheep in the United States are in the 11 Western States and Texas. The estimated value of the sheep in these States exceeds $100,000,000, and for every dollar invested in sheep several dollars are invested in land, equipment, feed, labor, and other factors incidental to operation. Accordingly, the great importance of the sheep industry in the range area of the West is evident.

The sheep of the West had their origin principally in two distinct sources—improved types brought from the East and unimproved native sheep trailed from the Southwest. The native sheep were undoubtedly descended from Spanish stock brought into Mexico and California by early Spanish explorers. Many years of uncontrolled breeding had reduced these animals to a very inferior, light-shearing type. After being brought to the western range country these sheep were greatly improved by intelligent breeding practices and the introduction of new blood.

Formerly, because of an abundance of free range and cheap labor and the long distances to market, few young sheep or lambs were marketed. The wethers were kept in large bands until 3 or 4 clips of wool had been obtained and then they were shipped to market. Production costs were low, and the season's wool clip made a compact, relatively nonperishable product, well adapted to the long hauls over poor roads to the shipping points.

In recent years lamb or mutton has taken the place of wool as the principal source of revenue from range sheep. This change has been brought about largely by the reduction of free range, the advent of better transportation, and the increased market demand for lambs. The range sheepman accordingly markets most of his lambs at from 4 to 6 months of age and retains only the ewe lambs necessary to maintain his band.

TYPES AND BREEDS OF SHEEP ON WESTERN RANGES

In almost every section of the West various types and breeds of sheep have been used in an effort to find the kind best adapted to each particular section. The predominant present type is the finewool sheep or one which has a foundation of finewool blood. Formerly the Merino was very largely used, but the larger, smoother, more productive Rambouillet has rapidly taken its place. Various other blood lines involving principally the longwool and "down" breeds have been used, either pure or crossed with the finewool breeds.

FINEWOOL BREEDS

The finewool breeds, Rambouillet and Merino, are particularly adapted to much of the western range. They are hardy and can withstand short feed and drought. In addition, their strong herding instinct makes it possible for one man to take care of large numbers even in rough country. The Rambouillet ewe (fig. 1) is a fairly good mother, produces an acceptable feeder lamb, and has a longer-stapled fleece of less shrinkage than the heavily wrinkled type of Merino. The Rambouillet ewe is generally used as the foundation for the production of the crossbred, so desirable for the raising of fat lambs on the high western ranges. As compared with the Rambouillet, the heavily wrinkled type of Merino is a relatively poor mother. For these reasons the Rambouillet has rapidly taken the Merino's place on the range. Some success has been achieved in breeding Merinos for freedom from heavy skin folds, but the progress has not been so great as with Rambouillets.

LONGWOOL BREEDS

The longwool breeds include the Lincoln, Cotswold, Leicester, and Romney Marsh. These breeds are undesirable as range animals because of the difficulty in herding, lack of hardihood on the range, large coarse lambs, and extremely coarse fleeces. The few longwool sheep that are raised in the range country are produced on a small scale under fence, for the production of rams. The rams, particularly the Cotswold and Lincoln (fig. 2), are used on the range to cross with the finewool ewes in the production of the popular crossbred ewe type.

DOWN BREEDS

The Hampshire and Suffolk breeds are used in the western range country for the production of market lambs. The purebred Hamp-

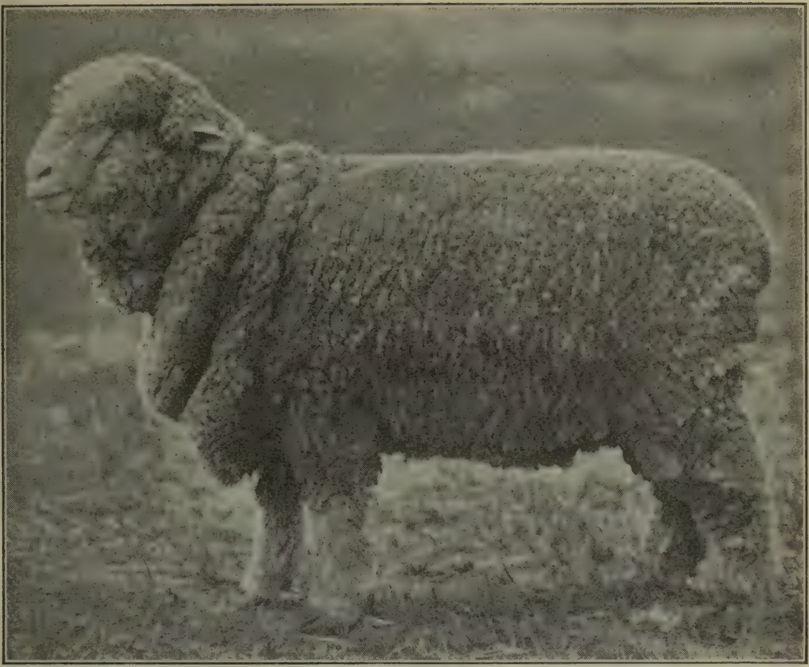


FIGURE 1.—A Rambouillet ewe typical of many finewool ewes on western ranges. Rangemen are breeding not only for such smooth-bodied sheep, but for freedom from the large neck folds that this ewe has.

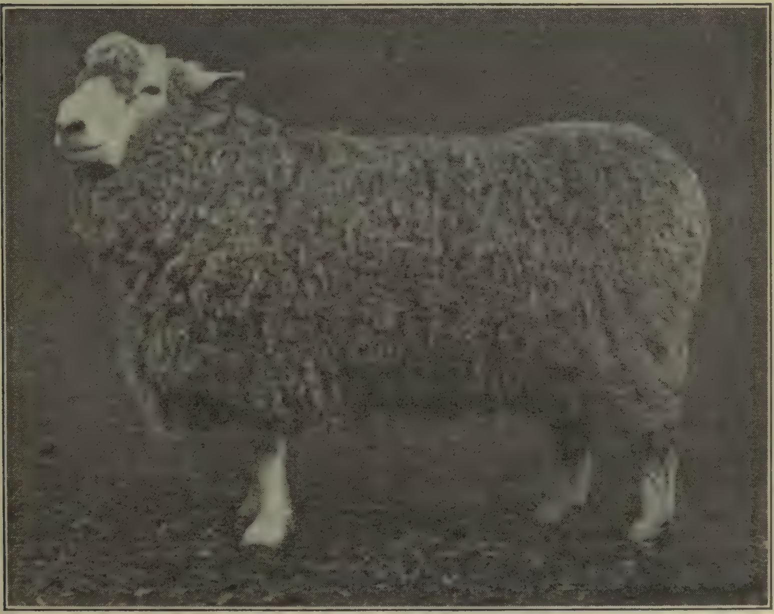


FIGURE 2.—Lincoln ram, a sheep of the longwool type.

shire also is raised in comparatively large numbers, but it does not have the herding instinct and is a very poor wool producer under range conditions. It is kept primarily for the production of breeding rams. Hampshire rams (fig. 3) are very popular and are used largely on crossbred and finewool ewes. The Suffolk (fig. 4) is used to a limited extent in a few localities. The purpose and the general type of lamb produced are essentially the same as in the case of the Hampshire.

MINOR RANGE BREEDS

The Karakul, Tunis, and other minor breeds of sheep have been used to a very limited extent in some sections of the West, but it appears that they will continue to have only a small place in the range sheep industry.

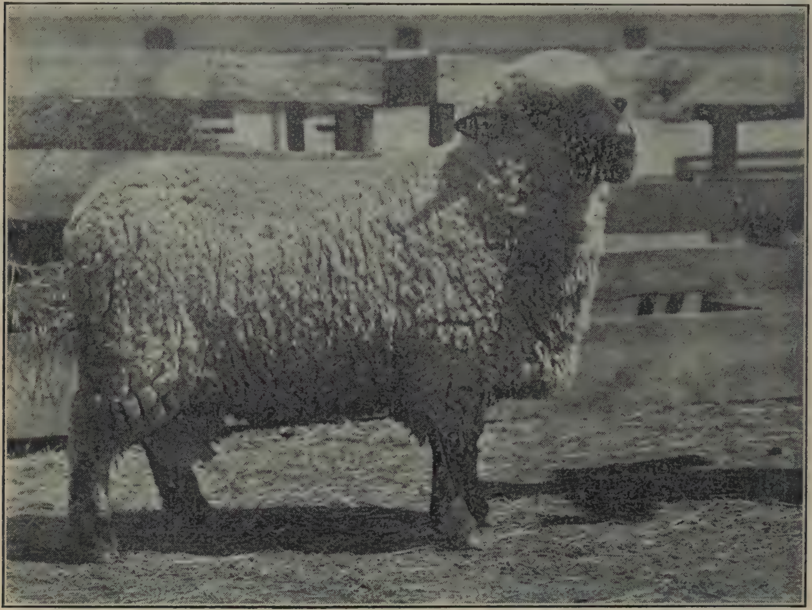


FIGURE 3.—Hampshire ram typical of those used on the range to sire market lambs.

CROSSBREDS

Strictly speaking, a crossbred sheep is the result of crossing any two distinct breeds, but as applied to western range sheep it ordinarily refers to the crossing of a longwool and a finewool breed. Rams of the longwool breeds previously mentioned are used on the Rambouillet and Merino ewes, but the most popular longwool rams are the Cotswold and Lincoln.

The crossbred ewe has enough of the finewool blood to be easily herded. She is more prolific than the Rambouillet and is an excellent mother. In addition, her fleece is long, heavy, light shrinking, and of desirable quality. Most western fat lambs are produced by using rams of the down breeds, notably Hampshires, on crossbred ewes. When weaned after summering on the high ranges of the national forests, these lambs are a very superior product.

Lambs produced by crossing (1) the Hampshire and a finewool breed, and (2) the Hampshire breed and crossbreds, are of desirable mutton conformation, mature early, and are very popular with both the producer and the meat trade. The drawback in the use of the Hampshire, which is a mutton breed, is that the tendencies of the lambs to produce light fleeces make it necessary for both ewe and wether lambs to be sent to the block, and the producer, therefore, must make other arrangements to obtain replacements to keep up the ewe flock.

Recognizing the desirability of a sheep that combines the longwool and finewool type and that also breeds true, western sheepmen have developed several types and breeds. The best known is the Corriedale (fig. 5), which originated in New Zealand as a cross between the Lincoln and Merino. Because of its foundation of Merino blood, the Corriedale is somewhat smaller than most of the crossbred sheep of the range country. Numerous importations have been made into the United States, and the breed is well liked on the range where forage is fairly abundant and lush while growing. The Corriedale lamb is of excellent quality, matures fairly early, and is of medium size. For these reasons it is well liked by the packer and butcher. The fleece is of medium weight, good length, and usually of three-eighths-blood quality. There are relatively few Corriedale ewes in the United States, and grade Corriedale rams usually find a ready sale.

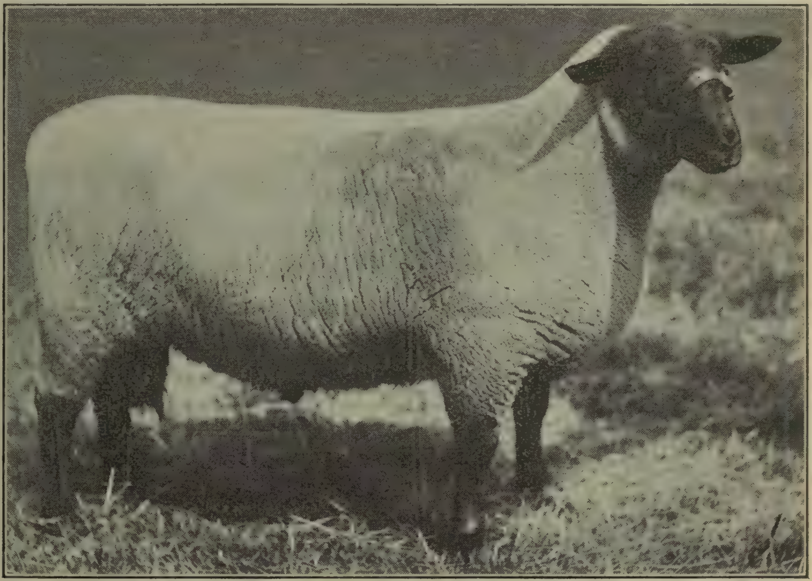


FIGURE 4.—Suffolk ram.

Among the other more or less fixed crossbred types are the Columbia, Panama, and Romeldale. The Columbia (fig. 6) and Panama both have Lincoln and Rambouillet blood lines as their foundation, whereas the Romeldale is a cross between the Romney Marsh and Rambouillet. These crossbred types are of a more recent origin and are not so well established as the Corriedale. The individuals are ordinarily larger and their fleeces are longer, heavier, coarser, and of somewhat less quality than those of the Corriedale.

SELECTION OF BREEDING STOCK

The selection of breeding stock depends on the phase of the sheep industry in which the sheepman engages, whether in the production of market lambs, stock sheep, or purebreds. It is commonly influenced also by range conditions and the capital, experience, and inclination of the operator.

MARKET-LAMB PRODUCTION

In market-lamb production the operator gives relatively more consideration to breeding for the production of lambs than of wool, but the successful operator does not overlook any practice that will increase his revenue from wool. Most producers use rams of good mutton type and breeding on finewool or crossbred ewes.

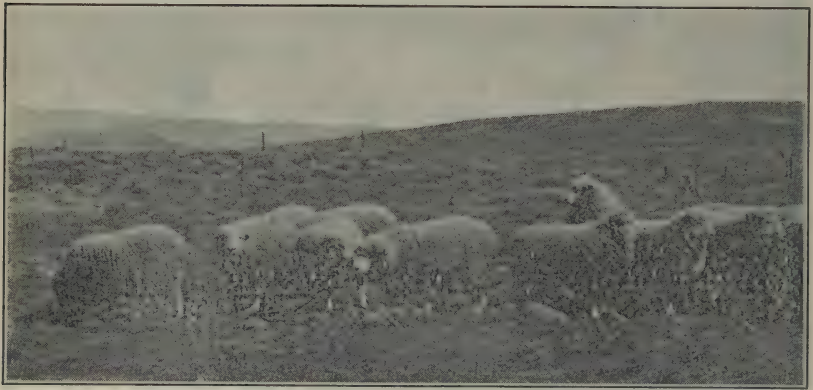


FIGURE 5.—Corriedale rams at the United States Sheep Experiment Station, Dubois, Idaho.

In the sections that produce early lambs, the ewes are generally bred on pastures early in the fall and lamb in sheds from late in January to early in March. The lambs are raised on the valley and foothill ranges (fig. 7) and are marketed early in the summer before the low ranges dry up. In some valley sections, especially in California and Arizona, lambs are born in November and December and marketed in April and May. Aged ewes are frequently made use of in these sections where lambs are born during the period from November to March.

Another very general practice involves more strictly range production. The ewes are bred early in the winter, either on the range or in the feed lot, and drop their lambs on the range, usually during May. After the ewes are sheared, the bands are gradually moved toward the high mountains (fig. 8), and the lambs are finished on the abundant weed feed of these mountain areas. These lambs are marketed in September and October. Aged ewes ordinarily are not used in this type of operation.

STOCK-SHEEP PRODUCTION

In sections where range feed conditions are not suitable for fat-lamb production, the raising of stock sheep is more generally recommended and practiced. Most of the Plains areas, because of grass forage, scarcity of water, and absence of high summer range, are not suited to the production of fat lambs. The finewool type of sheep is very hardy, an efficient wool producer, and yields a lamb which is in good demand both for restocking and feeder purposes. For these reasons stock sheep are largely produced on the semiarid ranges. There is comparatively little early or shed lambing, most lambs being born on the range in May. They are weaned in September and October, and the wether lambs are sent to feed lots for finishing. The income from wool is relatively greater in proportion to the income from lambs for the producer of stock sheep than for the producer of fat lambs. Therefore, a great deal of attention is given to wool production, and in some sections of the Southwest it is given more attention than the conformation of the ewe and her ability to produce a desirable lamb.

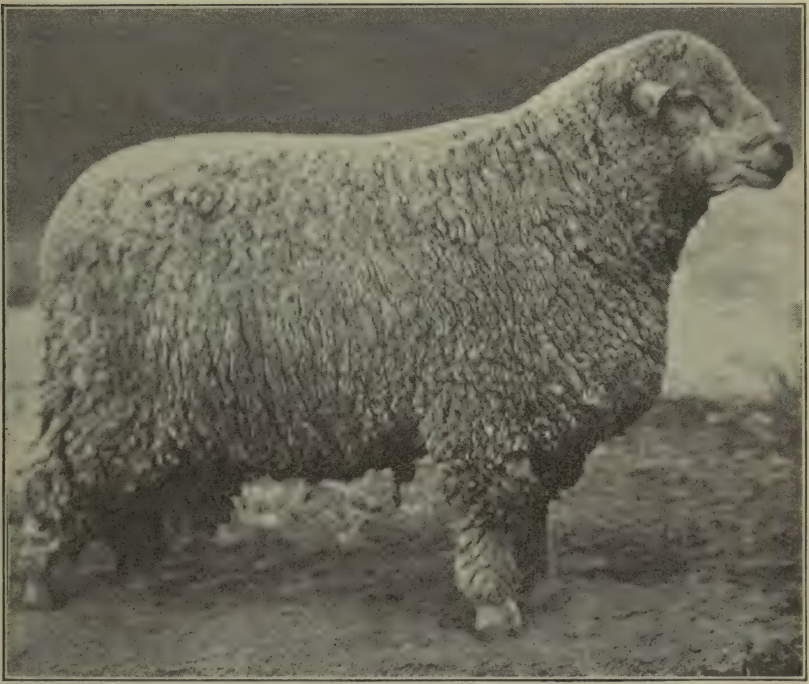


FIGURE 6.—A good type of Columbia ram produced by the Bureau of Animal Industry at the United States Sheep Experiment Station, Dubois, Idaho.

PUREBRED-SHEEP PRODUCTION

Purebred-sheep production is a highly specialized branch of the industry and is ordinarily undertaken in the range country only for the production of breeding rams to supply the range operators. The investment per ewe for breeding stock, equipment, labor, and feed is high, and unless the operator has the necessary capital and experience he should not undertake this branch of production. Many thousands of registered and other purebred rams are raised and sold yearly by private sale and through the auction ring. The principal breeds and types raised for the use of range men are the Rambouillets and Hampshires, and smaller numbers of Suffolks, Lincolns, and others.

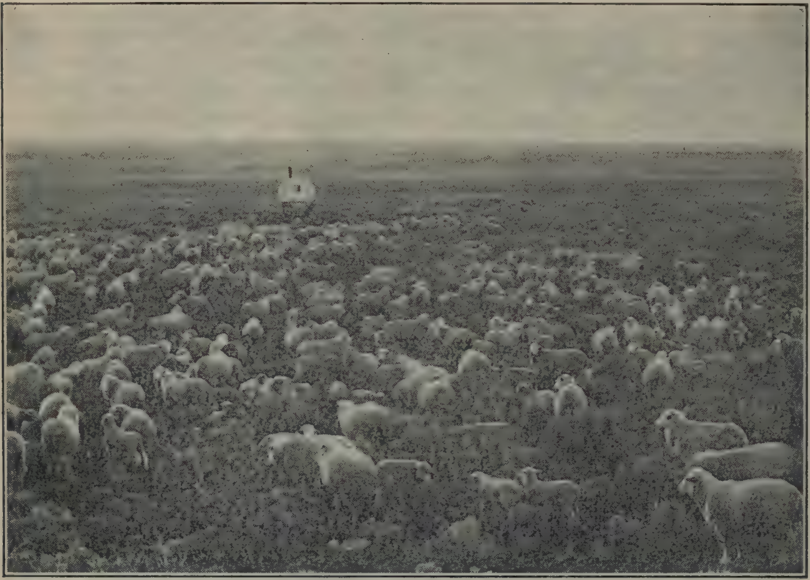


FIGURE 7.—A band of ewes and their lambs on the spring-fall range at the United States Sheep Experiment Station, Dubois, Idaho.

FIGURE 8.—Sheep on high mountain range.

SELECTION OF RAMS

After the breeder has decided on the general type, he should select rams superior in breed type, mutton conformation, and wool production. Since a ram may stamp his characteristics on from 20 to 100 or more lambs each season, the importance of care in selection of breeding rams cannot be overemphasized. The breeder should choose rams of the same general type as the ewes for purebred or stock-sheep production, and superior mutton-type rams for market-lamb production. It is a short-sighted policy for the breeder to use inferior or off-type rams.

SELECTION OF EWES

Regardless of the phase of the range industry undertaken, the operator must use great care in selecting his ewes, as well as his rams, if he is to obtain maximum returns. He should select for size, breed type, mutton conformation, age, soundness, prolificacy, and wool production.

Other things being equal, a ewe of average or large size will be a more economical producer than a small one, as she will return more pounds of wool and mutton for the feed consumed and the care given her. Breed type is particularly important in the purebred business, but under any circumstances the rangeman should strive for uniformity of type within his bands. The vigorous ewe of good mutton conformation is a far better potential producer than one of poor conformation.

The age at which ewes cease to be efficient on the range varies from 5 to 7 years. Finewool ewes generally are profitable longer than ewes of the mutton types. Soundness in ewes consists largely in freedom from defects in teeth, udders, and teats and from parasitic and infectious diseases. Although ewes that produce twins are more profitable than those that give birth to single lambs, it is better to have ewes raise single lambs every year than to have them raise twins only half the time and then fail to raise any lambs during the remainder.

Since one third to one half the income from the ewe is derived from her fleece, it is to the advantage of the raiser that his ewes produce heavy fleeces of a desirable quality of wool. The animals should be well covered with long, dense, uniform fleeces of the fineness characteristic of the breed or type. Wool production depends also on the manner in which the sheep are handled. Wool growth as well as body growth responds to favorable feed conditions.

REPLACEMENT OF EWES

To maintain the number and the desired average age of the band, the rangeman must replace the ewes he disposes of or loses each year with an equal number of young ewes. He may either raise or purchase these replacements. If the lambs raised are of the same type as the breeding ewes, the breeder ordinarily retains his own replacement stock. But when he uses black-faced rams on white-faced ewes to produce market lambs, he should market both ewe and wether lambs, for the black-faced ewe lamb is not desirable for stock purposes. In this instance the rangeman purchases his replacement stock, either as lambs or yearlings, from a section where stock sheep rather than market lambs are produced. Oregon, Nevada, Montana, and portions of adjoining States furnish many white-faced ewe lambs annually for the market-lamb producer of the Northwest. In making his replacements the rangeman should be careful that his uniformity of type is not disturbed.

MANAGEMENT OF RANGE SHEEP

GENERAL ORGANIZATION

The range-sheep unit, or band as it is called, may vary considerably in size, but is usually composed of from 2,000 to 2,500 sheep. From lambing time until weaning approximately 1,200 ewes with their lambs are kept together in a band. After the lambs are weaned, two bands of ewes are combined for the breeding and winter-feeding period.

With slight variations and one notable exception, the sheep producers of the western ranges use the same general system in handling their sheep. They give a band into the care of one herder who, with his dogs, stays with the sheep day and night throughout the season. He is quartered in a wagon equipped for his needs, except during short periods when he is near headquarters or in the summer when he takes his sheep to high mountains where his wagon cannot follow. In this case he uses a tent. A camp tender, with his wagon and team or pack animals, attends to the herder's needs by supplying him with food and moving his camp as the sheep exhaust the grazing in the immediate vicinity. One camp tender takes care of two or more herders, depending on the distance he must haul supplies and the roughness of the country. In large organizations a range foreman usually is in charge of several bands on his particular allotment of range, whereas in smaller outfits of 1 or 2 bands the owner may take the place of both the camp tender and the range foreman. Additional help is required seasonally, especially during lambing and shearing.

The exception to this general method is found in some parts of the Southwest, particularly Texas, where sheep are kept in paddocks or pastures. Here the operators own or have long leases on nearly all their grazing land, an arrangement which enables them to build fences and let the sheep graze undisturbed in these large pastures. They employ fence riders at all times and additional help during lambing, but on a year-around basis one man can attend to a much larger number of sheep than he can under the herder system. The system just described has the additional advantage that when the sheep are unmolested they follow their own inclinations and make more complete utilization of feed.

Intelligent dogs, when obedient and otherwise properly trained, are valuable aids to the herder in managing his sheep. However, many untrained dogs are often found with sheep, and this situation is fully as bad as having no dogs at all.

BREEDING

The time of breeding in different localities varies, depending largely on range and weather conditions during lambing, but the general principles involved are very similar throughout the range country. The sheepman desires that all ewes be bred to lamb in a short space of time, thereby insuring a lamb crop of reasonably uniform age. He also desires a good percentage of lambs. To obtain these results the progressive sheepman is coming to realize that it is essential to have a uniform band of thrifty ewes, good vigorous rams, and a breeding range with plenty of feed.

Many sheepmen set aside a part of the range particularly for breeding and do not harm it by allowing the stock to overgraze it before breeding time. They feed very little grain when breeding for early winter lambs, but when breeding for May lambs they generally feed some concentrate to the ewes. Feeding whole corn or cottonseed cake on the ground at the maximum rate of one fourth pound per head per day is the practice usually followed. This feeding is ordinarily continued until the sheep are brought into the feed lot. When breeding for late-winter and early-spring lambs, most rangemen plan to " flush " their ewes, that is, to give them extra feed at breeding time, in an effort to obtain a good lamb crop. They rent stubble fields and alfalfa meadows and allow the ewes to graze them during the breeding season so that the animals are gaining weight when bred.

Unless the rams are in good flesh before breeding time they should be conditioned with grain for from 3 weeks to a month before they are turned in with the ewes. From 1 to 2 pounds of whole oats daily is an excellent feed for this purpose. Unless the range is extraordinarily good, the usual practice is to continue grain feeding throughout the breeding season. Under different conditions and with different individuals various methods of handling the rams in the band are used. Many rangemen do not feed them at all, but take them out after a short period and substitute fresh rams. Other sheepmen feed their rams during the day and turn them in with the ewes at night, and still others feed their rams at night and turn them in with the ewes during the day. Any of these methods, if intelligently followed, will insure a good lamb crop. The number of ewes allotted to one ram on the range varies greatly, but ordinarily best results are obtained when 3 rams are allotted to each 100 ewes. The length of the breeding season also may vary, but the rams should be left in at least from 35 to 40 days.

WINTER HANDLING

The range sheepman may choose between wintering on the range and wintering in the feed lot. Most range sheep are brought into the feed lot at some time during the winter. The time varies considerably, depending on the condition of the sheep at the beginning of the winter, condition of the range, the quantity of feed available, and the severity of the winter. In some particularly favored locations and during mild winters the sheepman may allow his stock to graze for the entire winter.

WINTERING ON THE RANGE

Since the cost of wintering is one of the large items of expense for the range sheepman, he usually keeps the sheep on the range as long as possible in the winter. Many areas in the West are particularly suited for winter ranges, and hundreds of thousands of sheep are grazed there each year (fig. 9). Notable examples are the Red Desert in southern Wyoming, and the Nevada and Utah desert areas. Three essentials of a good winter range are abundant feed, snow, or other form of moisture, and shelter in stormy periods. Areas with a deficient water supply ordinarily are good winter ranges because stock are not able to graze on them in the summer, consequently a good growth of range feed is saved until snow comes. The stock then are able to graze this range and to use snow to satisfy their water requirements.

Sheep browse a great deal during cold weather and utilize rougher feed than at any other time of the year. Many sheepmen make a practice of feeding some grain concentrate on the winter range each year, and some make provisions for an extra supply of feed that can be used during severely cold or stormy periods.

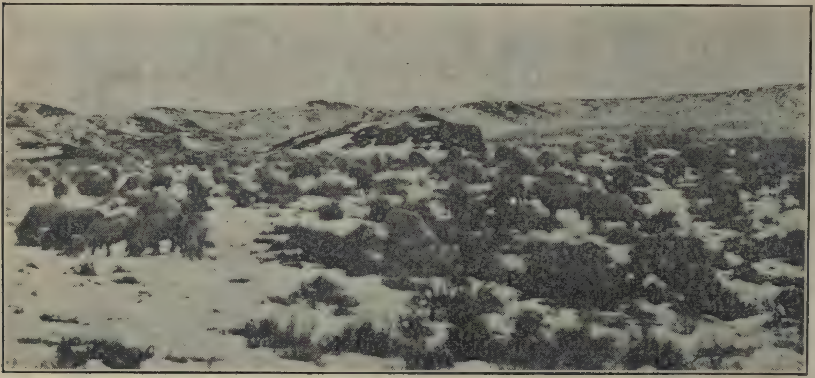


FIGURE 9.—Ewes on winter range at the United States Range Livestock Experiment Station, Miles City, Mont.

After being weaned, lambs should have an abundance of feed in order that their growth may not be retarded. A good common practice is to turn them into stubble fields and pastures until the feed is short or the weather becomes too severe, and then begin feeding them hay. It is often advisable to give them a small quantity of grain throughout the first fall and winter after weaning.

WINTERING IN THE FEED LOT

Alfalfa hay is the standard winter roughage for sheep in feed lots (fig. 10) in the range country, but some native hay is fed when alfalfa is not available. The hay is ordinarily purchased in stack at a price that may or may not include pasture privileges. If the pasture is obtained it is usually grazed by the ewe lambs and the old ewes that are unable to get their living off the range. Hay is hauled from the stack and fed on the ground. The feed ground should be changed often to prevent feed lots from becoming insanitary. Essentials of a good winter feeding ground are accessible hay, shelter, and water. Very little shelter, except a natural windbreak, is necessary. Some sheep come through the winter without having had any source of water except snow to satisfy their water requirements, but when they are on dry feed it is decidedly preferable to have a supply of open water. If mature sheep are in thrifty condition when they are brought into the feed lot, grain is not usually fed with alfalfa hay, but a protein concentrate, such as cottonseed cake, is desirable when native hay is fed. In figuring hay requirements for a band of range sheep when hay alone is fed, the sheepman should allow not less than from 4 to 5 pounds per ewe per day, depending on its quality. He will, of course, allow less than this when grain also is fed. When conditions permit it is often the practice to feed a small quantity of hay and permit the sheep to graze each day.

Sheep are not able to utilize as rough and stemmy hay as some of the larger classes of livestock; for this reason sheep waste somewhat more first-cutting hay, unless it is of a very fine quality, than they do of the later cuttings. During extremely cold weather, and when sheep are first brought in from the range, it is wise to sort out the poorest hay and feed it first, as the sheep will eat it better at this time than later. The hay of better quality is then reserved for the end of the feeding period and during lambing. Great care should be taken in feeding hay that contains wild barley or foxtail. Seed heads of these plants do great damage when mature, especially to finewool sheep. The seeds not only get into the eyes and blind the animal but they collect inside the mouth and cause sores and starvation if not removed. The sheep should be examined carefully at short intervals for the purpose of removing seed heads. Hay containing foxtail should never be fed in racks. Moldy hay also is dangerous, particularly to ewes heavy with lamb, as it is a frequent cause of abortion.

FIGURE 10.—Ewes on winter feed lot near Hamer, Idaho.

Breeding rams may be wintered on roughage and a small quantity of grain since there is no object in getting them in high condition. From 5 to 7 pounds of fair alfalfa hay, depending on the size of the ram, and 1 pound of whole oats, form an ideal winter ration.

SPRING HANDLING

The largest problem confronting the range sheepman in the spring is lambing. His success at lambing time always has a very definite bearing on the income derived from his business.

SHED LAMBING

Early shed lambs are raised in many parts of the West for the purpose of getting the lambs on the market at a date somewhat ahead of the large run of range lambs. These lambs shipped late in the spring and early in the summer arrive at the markets at a time when the demand is brisk, the supply small, and prices relatively high. For successful lambing late in the winter or early in the spring it is necessary to have, in addition to sheds and other equipment, an abundant supply of feed and sufficient early range forage to finish the lambs after turning them out on the range. During lambing time an abundant supply of good hay and grain is necessary, and some form of succulent feed is highly desirable.

For from 3 weeks to a month before lambing, the ewes should receive some grain. Whole oats at the rate of one-half pound per ewe per day has proved to be a very good grain ration, but corn, wheat, barley, and various grain mixtures have been successfully used. Some corn silage, beet pulp, or other succulent feed may be fed in limited quantities before lambing and in larger quantities afterwards, to stimulate milk flow. The best quality of hay should be reserved for this time. The following rations have proved successful:

Ration before lambing		Ration after lambing	
Alfalfa hay	4 pounds.	Alfalfa hay	5 pounds.
Whole oats	½ pound.	Corn silage	2½ pounds.
		Whole oats	¾ pound.

These rations are suitable for average-size range ewes weighing from 90 to 115 pounds. Ewes with twin lambs may have their milk flow stimulated by receiving more grain and succulent feed. These rations include feeds that are commonly grown in the irrigated valleys of the West.

In shed lambing, a large number of laborers are necessary during lambing. They include the lambing foreman, hay haulers, feeders, drop pickers for day and night, sucklers (men to assist weak lambs), and men for moving small groups of ewes and lambs and for miscellaneous work.

The drop picker uses a low cart and gentle horse. When the lamb is born he loads the ewe and lamb into the cart and hauls them into the shed, where they are placed in a small individual pen. These pens are ordinarily 3 feet 6 inches square, arranged in a row down the sides and through the center of the shed. The suckler watches the lamb carefully for the first few hours after birth and if necessary gives it assistance in suckling. After the ewe and lamb have been together for from 12 to 24 hours and the lamb is mothered well, they are turned out into a larger pen with from 6 to 8 others. In this pen they have access to feed and water. Ewes are usually not fed in the individual pens but receive all the water they want. The small groups are watched carefully, and all weak or backward lambs are returned to individual pens. After a day or so the small groups are further combined and from 18 to 20 ewes and their lambs are put in a larger pen with an outside run, so that the lambs may get the benefit of the sunlight. These pens should have good drainage and dry bedding at all times. This system of gradually combining the groups as the lambs grow older and stronger continues until there may be from 100 to 200 head in a group at docking time, when the lambs are from 10 days to 2 weeks old. The ewes are fed liberally until green feed appears on the range, and at that time they are combined into a summer band of from 1,000 to 1,500 ewes with their lambs.

Some sheepmen handle twin lambs in the same way as they do the single lambs, and others form groups of twin lambs, give them extra feed and care, and ultimately make them up into a band of twin lambs.

The main advantages of the shed system of lambing are: (1) The band may be lambed early before grass comes, and the lambs may be marketed correspondingly early; and (2) more care can be given to the band during lambing, resulting in a greater percentage of lambs raised. The number of lambs marketed commonly is well over 100 percent of the number of ewes nursing lambs in the band.

LAMBING SHEDS

In any locality where the lambs are born before green grass comes, shelter is necessary. Sheds may be constructed of lumber, galvanized iron, canvas, or straw, or large tents may be used. The interior arrangement of lambing sheds varies with almost every outfit, but the principle is the same in all. Small individual claiming pens, or "jugs", are provided where the ewe and new-born lamb can be placed. Then a system of pens is arranged so that as the lamb grows older the ewe and lamb are gradually combined with larger numbers of ewes and lambs. It is desirable, if not absolutely essential, that all the pens in which the lambs are placed after they are a few days old be provided with a shelter and an outside run. Figure 11 shows plans for a lambing shed and outside pens, and figure 12 shows the construction of individual pens within the lambing shed.

It is not always possible but it is highly desirable that space be provided in the shed for the lambing band. In cold stormy weather many lambs may be saved by having the lambing band under shelter. By some crowding the band can be accommodated in a space providing a minimum of approximately 6 square feet per ewe, but more space is preferable. Ample ventilation is essential, which may be provided by doors, windows, and overhead ventilators.

All doors through which whole bands of lambing ewes are to pass should be at least 12 feet wide, and preferably 24 feet, to prevent crowding on entering and leaving the shed. Small gates, doors, and other openings are one of the chief causes of abortion in ewes.

RANGE LAMBING

In range lambing the sheepman plans to have his ewes begin to lamb as soon as grass is available in the spring. A part of the range which contains suitable feed, shelter, and water is set aside for lambing, and the ewe band is moved in shortly before the lambs are due to be born. When the first lambs are born the day's drop, with the ewes, is gradually brought together before night, and the rest of the ewe band is moved away under charge of the herder. Flags or scarecrows are set up near the group of lambs and ewes, or fires are built to protect it from coyotes during the night. Similarly the lambs born on the bedground at night are left by the main band in the morning. These small groups of ewes and lambs are given the best possible care, weak lambs are helped to suck, and as they become a little older and gain in strength they are combined until small bands of ewes and lambs are made up and given into the care of herders. Because these young lambs (fig. 13) are not able to travel long distances it is necessary that feed and water be close by.

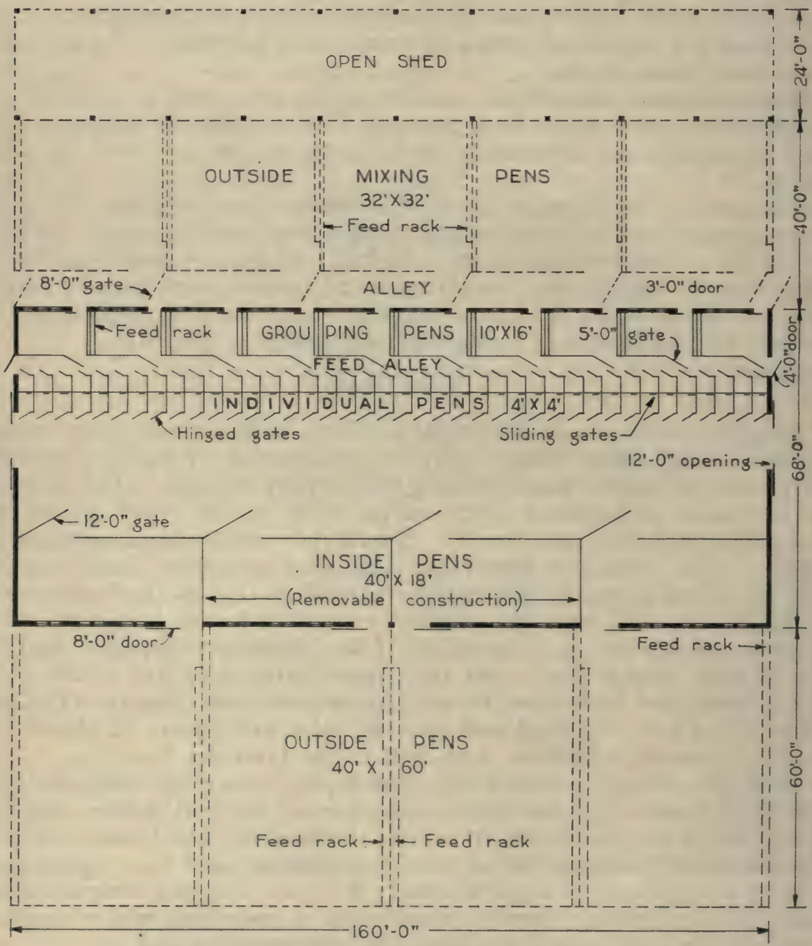


FIGURE 11.—Layout of lambing shed and outside pens.

Small tents are frequently used to protect ewes with new-born lambs during storms. Because of a lack of shelter and less individual attention, losses on the range are a great deal heavier than in shed lambing. It is not unusual to lose practically all the lambs born during a severely stormy period.

CARE OF WEAK AND DISOWNED LAMBS

In either range or shed lambing, the sheepman makes every attempt to save all the lambs. Weak lambs may be revived by artificial respiration and the use of stimulants. Chilled lambs may often be saved by putting them near a stove, wrapping them in a warm pelt or sack, or immersing them in water at a temperature that is just bearable to the hand. After a lamb is revived it should be given small quantities of its mother's milk at frequent intervals until it is able to nurse unaided.

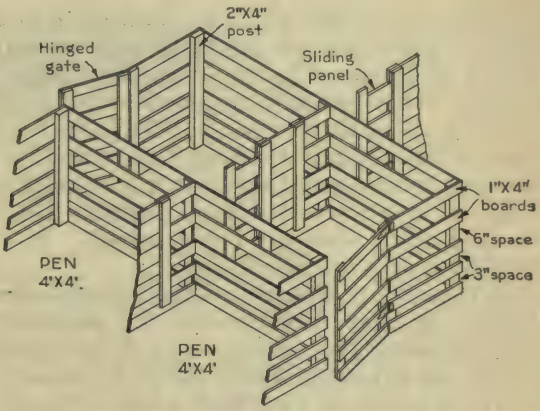


FIGURE 12.—Individual pens within lambing shed.

Frequently ewes disown their lambs. This trouble is particularly common among finewool ewes, yearling ewes, and ewes with an insufficient milk supply. If the lamb is energetic and strong, the ewe will almost invariably own and mother it if she is tied securely or hobbled so that she cannot run away. A few hours may suffice with some ewes, whereas it may take days with others. A ewe that has lost her lamb at birth will generally claim an orphan lamb if it is rubbed with the dead lamb or the afterbirth, or it may only be

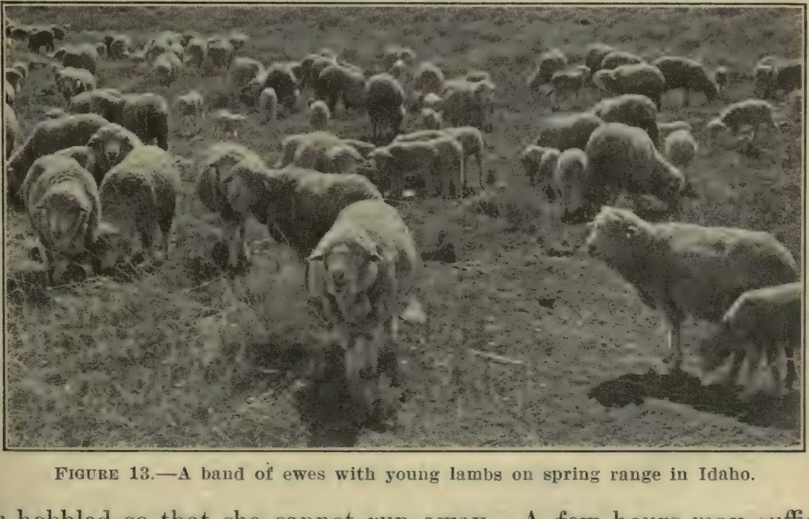


FIGURE 13.—A band of ewes with young lambs on spring range in Idaho.

necessary to milk a little of the ewe's milk on the lamb's head and rump. If a lamb is several days old before it dies, tying its pelt over an orphan lamb is usually the most effective way to make the ewe claim the orphan. The good lamber is ingenious in finding ways to save orphan lambs and rightly figures that each one saved means additional money at weaning time.

CORRALS AND FENCES

Corrals and fences are a necessity in any type of sheep operation, particularly around lambing and shearing sheds for separating bands of sheep. They may also be needed at locations on the range distant from ranch headquarters for sorting sheep without undue trailing to permanent sheds. The size of corrals may vary, depending on the number of sheep to be handled at one time, but a corral 100 feet square, or of equivalent area, will provide enough room for a band of 1,000 ewes to rest comfortably overnight, or for 2,000 ewes to be held while they are being sorted. In all cases corrals should be located on well-drained land.

Fences are ordinarily of four types—panel, woven wire, ordinary barbed or smooth wire with the strands close enough together to prevent sheep from going through the fence, and lath fence. For all sheep, particularly lambs, the panel fence is preferable, but the cost of construction is somewhat higher than that of the other kinds. A desirable type of panel fence constructed of 1 by 4 inch material is shown in figure 14.

A fence made of heavy-gage, woven wire strung on posts set from 6 to 8 feet apart is very satisfactory under most circumstances (fig. 14). A 2 by 6 inch plank on the top and bottom improves a fence of this type. This fence affords no shelter as does the panel fence, and lambs are likely to crawl through unless the mesh is very fine.

Wire fence with the strands close to the ground and close together at the bottom is probably the least desirable of the four kinds of fence, but when it is regularly inspected and repaired it will serve for holding mature sheep. Ordinary wire fences of 4 or 5 strands are often converted into sheep fences by the addition of several tightly stretched wires.

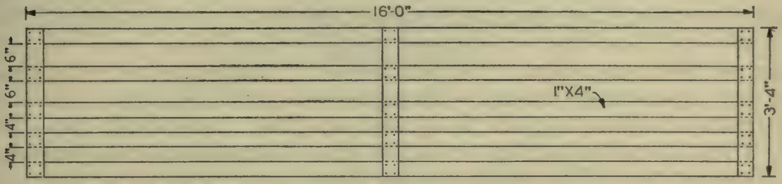
Another type of fence that has proved to be very satisfactory, especially when a portable fence is desired, is the so-called lath field fence. This fence is constructed of lath woven together with wire, as illustrated in figure 14. It may be purchased in compact rolls, and with steel posts it makes a very desirable sheep-tight fence with the added advantage that it is easily portable.

If only sheep are to be kept in the enclosures, a 42-inch fence is usually high enough. The cost of the material, particularly the panels and woven wire, will be less for a low fence than for a high one. Gates should be as wide as possible, 12 feet being the minimum desirable width.

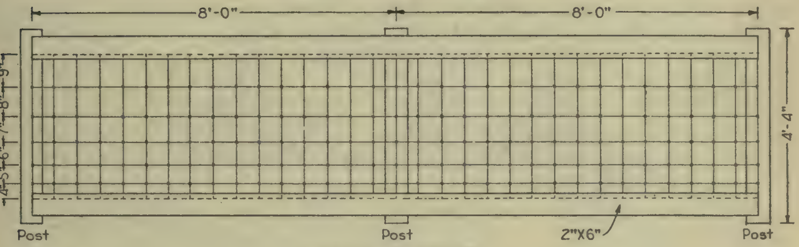
FEED RACKS AND TROUGHS

Suitable racks for the feeding of hay and troughs for grain are desirable, especially during lambing and when feed grounds are muddy. Most range sheep are wintered on fields where a great deal of room is available for clean feed grounds and the hay is scattered on the ground. Corn or cottonseed cake is also fed very successfully on the ground as long as it is not muddy, but when the animals are confined in pens and corrals racks are desirable to eliminate waste.

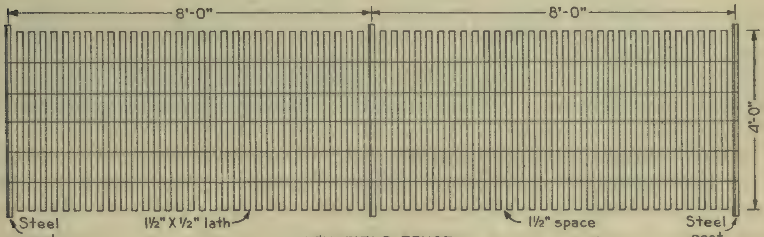
The ideal feed rack is a combination hay and grain rack which does not permit feed to be wasted. For very fine quality hay having little waste a rack with a small space 2 to 2½ inches between the slats is good, but when the hay is coarser, with more waste, a greater distance between slats is essential.



MOVABLE FENCE PANELS



WOVEN-WIRE FENCE



LATH FIELD FENCE
(50'-0" to 100'-0" sections)

FIGURE 14.—Three types of fence used in range sheep production.

In many instances, particularly in commercial lamb feeding, the animals eat through specially constructed feed panels. As the lambs eat the feed within reach, more is pushed up to them. Self-feeding troughs and racks are sometimes provided for the feeding of chopped hay and feed mixtures with a chopped- or ground-hay base. The construction of these racks, troughs, and other equipment is discussed fully in Farmers' Bulletin 810, Equipment for Farm Sheep Raising.

WATER TANKS AND TROUGHS

The provisions for water and its conservation on some types of range are very important, as water is the limiting factor in sheep raising on much of the semiarid range area. Many ranges, particularly those for spring lambing, are made usable by the construction of dams and reservoirs to retain the natural run-off of water. Other dry ranges have wells drilled to provide a water supply. In either case it is desirable to provide a system of troughs to water the stock (fig. 15). These troughs may be made of galvanized metal, wood, or concrete.

The arrangement of the water storage and troughs will depend upon the topographical conditions. One suggestion for a water supply is shown in figure 15. The tanks, preferably, should be located as close together as possible in order to conserve pasturage, but where two or more watering stations are required and the topography permits, they may be supplied from the same storage if it be of sufficient capacity. Concrete troughs should be made no longer than 60 feet and should be reinforced in order to provide against the development of cracks. Troughs built with the long side parallel to the hillside require less concrete than those built parallel to the direction of slope. A valve at the tank controls the supply to all the troughs. The desired water level is maintained in the several troughs by providing, in all but the last trough, overflow pipes connected with the next lower trough. Farmers' Bulletins 1279, Plain Concrete for Farm Use, and 1480, Small Concrete Construction on the Farm, contain information on the making and handling of concrete and the construction of concrete tanks and troughs.

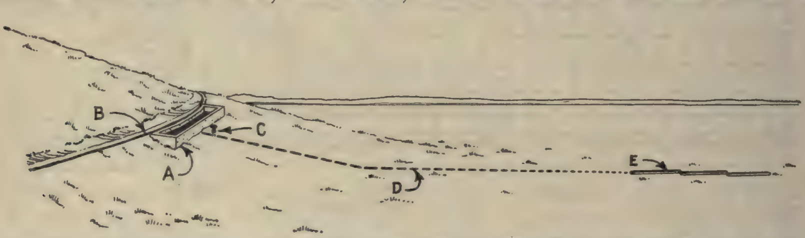


FIGURE 15.—Range-water supply for sheep: A, Concrete storage tank built into slope of watershed; B, collection ditch diverting snow water run-off into storage tank; C, control valve; D, pipe line; E, trough.

Water requirements per head vary from three-fourths gallon to twice that quantity per head daily, depending on weather, type of range, and kind of sheep. Ewes nursing lambs or on dry ranges require more water than ewes without lambs or ewes on green feed. When storage and trough space is planned, the number of sheep and the length of grazing period on that particular range should be taken into consideration. On many ranges where it is impracticable to provide permanent supplies, water is often hauled long distances in tank wagons or trucks, and portable troughs or tubs are provided to water the animals. This latter method is expensive and ordinarily is used only in emergencies during extremely dry periods. The storage supply is conserved by the addition of a cover on metal or concrete tanks or by fencing to exclude cattle and horses (fig. 16).

DOCKING AND CASTRATING

It is the uniform practice in the western range country to dock all lambs and to castrate all ram lambs except those in purebred herds. As performed by the rangemen, docking and castrating are not long or tedious jobs. An efficient crew of five men commonly docks and castrates 200 or more lambs per hour. The common practice is to dock and castrate lambs at from 7 to 21 days of age, although no serious trouble is experienced if the lambs are from 5 to 30 days of age. The tails may be seared off with a hot iron or cut off with a knife. The lambs are usually castrated by cutting off one third of the scrotum and pulling the testicles out with the teeth. This method is quicker and more sanitary than using the fingers. Recently several patented tools have been put on the market for docking and castrating, and good work can be done with these by experienced operators, although the process usually is somewhat slower with their use. On clean range with plenty of sunshine the effects of the operation will usually disappear in 12 hours.

SHEARING

TIME OF SHEARING

The time of shearing varies from February in some parts of the Southwest to July in the north. Most sheep in the western range country are sheared in May and June. It is best to shear after the weather has become warm enough so that newly sheared sheep will not suffer from exposure. Wet snowstorms and severe cold are sure to cause heavy losses among sheared sheep. Some rangemen shear before lambing, but the most of them wait until after lambing. The advantages of shearing before lambing are that the wool is removed from around the udder, making it easier for the lamb to suck, and less trouble is experienced with maggots, the source and cause of which are discussed later. The disadvantages are that the sheep often are sheared too early and are in danger of loss through exposure, and there is danger of causing abortion when ewes heavy with lamb are sheared.

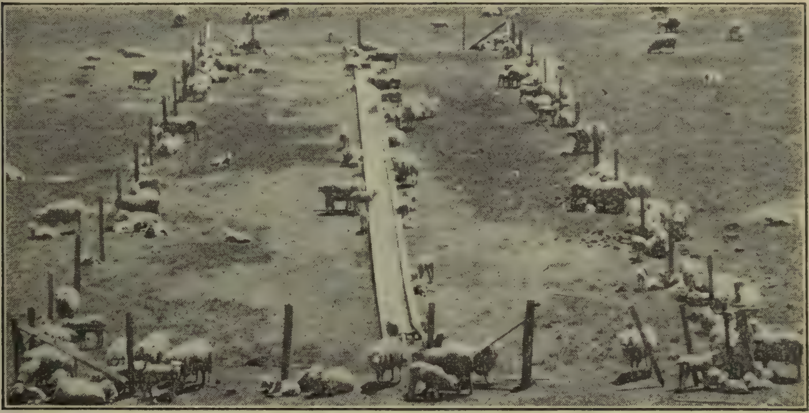


FIGURE 16.—Range watering troughs for sheep are fenced to exclude cattle and horses as a means of conserving the water supply for lambing time.

SHEARING SHEDS AND EQUIPMENT

Buildings for sheep shearing and for handling the wool vary from crude temporary sheds and stalls of corrugated iron, canvas, and other materials, to permanent sheds. The better types of shearing sheds provide means for sweating the sheep to make shearing easier, convenient pens for holding the sheep before and after shearing without mixing sheared and unsheared sheep (fig. 17), a clean space for shearing the sheep, and suitable equipment for sacking and storing the wool. It is desirable that the shearing shed be easily accessible both to the range and shipping points. Figures 18, 19, and 20 show plans for shearing sheds.

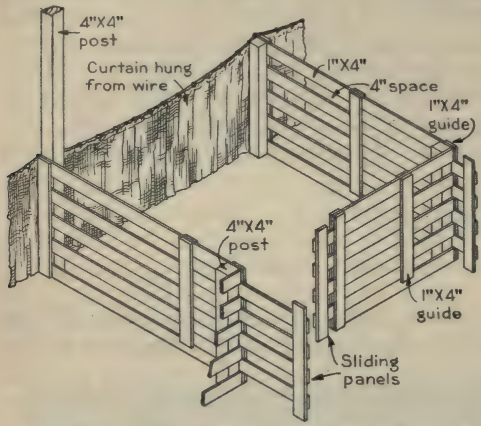


FIGURE 17.—Holding pens with sliding panels.

In some parts of the country operators of small bands trail their sheep to commercial plants and pay a fixed price per head to have them sheared, but operators of large bands generally have their own shearing equipment.

In the past hand-shearing was very popular, and many thousands of sheep are still sheared in this way, but most of the sheep in the range country are now sheared with machine shears. The use of the latter system has the advantage of being quicker, and the wool is taken off more closely and uniformly, with fewer second cuts and greater length of staple. Some operators think that machine shears

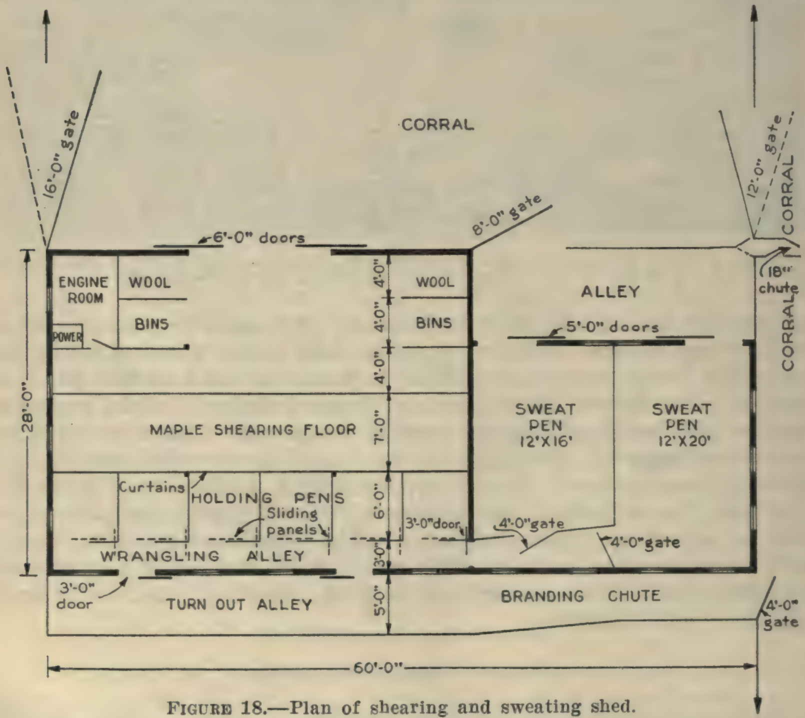


FIGURE 18.—Plan of shearing and sweating shed.

take the wool off too close, thereby exposing the sheep to the danger of storm, and for that reason they have their sheep hand-sheared.

CUTTING AND MOUTHING CHUTES

An efficient chute for separating or "cutting" sheep is an absolute necessity on every sheep ranch (fig. 21). Much use is made of it in separating ewes from lambs and sheared from unsheared sheep, and in making up the breeding bands. In connection with this chute a convenient place for mouthing (examination of the mouth), branding, and culling is desirable.

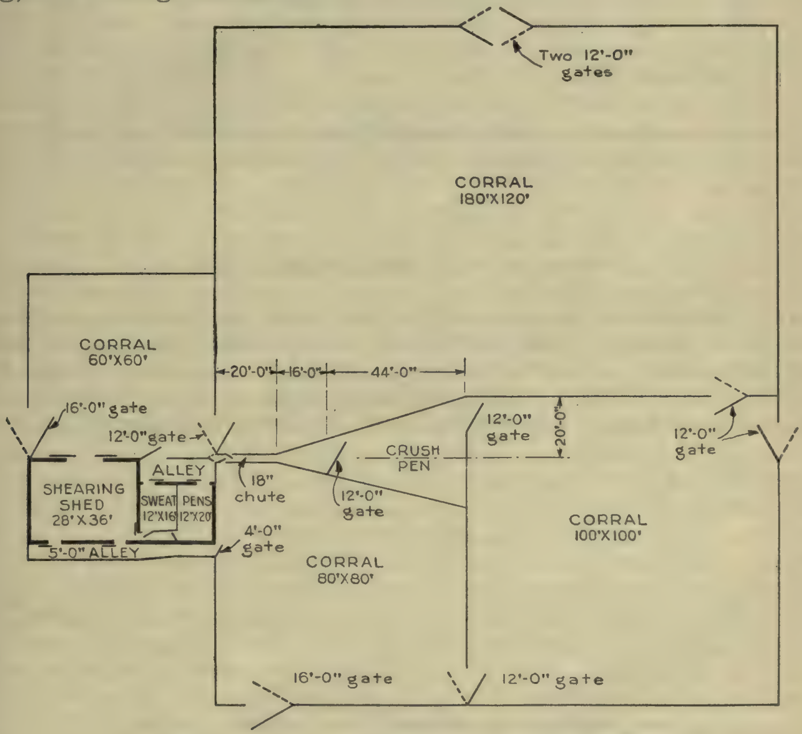


FIGURE 19.—Plan of shearing shed and outside corrals.

The chute should be long enough so that earmarks and brands on each sheep can be read easily and correctly before the animal reaches the cutting gates. The chute should be solid and high enough to prevent sheep from jumping over, and narrow enough so that they cannot turn around. In the crush pen (pen with movable side that holds sheep firmly) immediately in front of the chute, a panel may be conveniently placed to form a pen where sheep can be mouthed or branded. They may then be run through the chute and sorted into their respective divisions.

HANDLING WOOL AT SHEARING TIME

The careful shearer takes off the fleece so that it remains intact and avoids cutting the sheep and making second cuts in the fleece. One active man can take care of the shearing "board" (floor) for 5 or 6 fast shearers, tie the fleeces, and sweep up the tags. As the fleece comes off the ewe the tier removes all heavy tags, dung locks, and badly stained wool, rolls the fleece into a compact bundle with the loose ends inside, and ties it with hard paper twine. Binder and jute twines should not be used as they leave in the fleece ravelings that pass unnoticed and fail to take the dye when the wool is made up into cloth. Manufacturers are seriously concerned about this problem, and earnest efforts are being made to have all fleeces tied with paper twine. After being tied, the fleece is sacked with other fleeces of its kind. A careful record should be made of the number, contents, and weight of each sack, and the name or brand of the owner should be printed on it. All black and buck (ram) fleeces should be sacked separately. Whenever a black sheep is sheared the board should be cleaned carefully in order that objectionable black fibers may not be mixed with the next fleece.

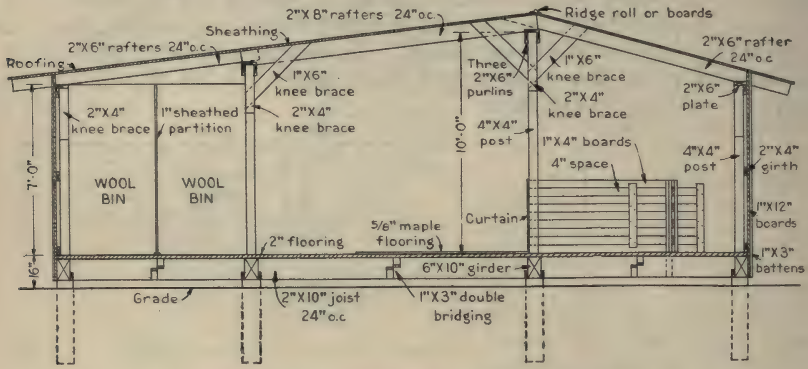


FIGURE 20.—Cross section of shearing shed.

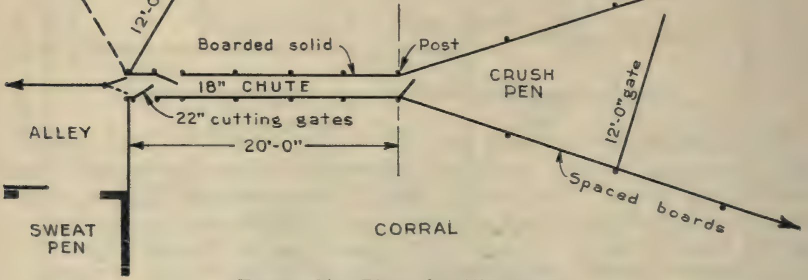


FIGURE 21.—Plan of cutting chute.

SUMMER AND FALL HANDLING

DIPPING

Dipping is resorted to on the range to control two very troublesome sheep parasites, the common sheep tick and the scab mite. Of the two, the tick is far more prevalent and the scab infestation the more severe and difficult to combat. Dipping in the correct manner and with the proper solutions is the only successful method of combating these infestations.

Severe infestations of sheep by ticks are very common in many parts of the range country. The damage done by these parasites is underestimated by the average rangeman. Sheep heavily infested with ticks are irritated to such an extent that they lose flesh, and the value of their wool is lowered by the discoloration due to the presence of the ticks. Lambs particularly suffer when ticks are prevalent, for after the ewes have been sheared the ticks remaining on them get on the lambs and retard their growth and fattening. The standard coal tar and nicotine sulphate dips are satisfactory for the eradication of ticks, but in order to destroy the pupae it is necessary to dip twice at intervals of from 24 to 28 days. Many rangemen locate their dipping vats conveniently near the shearing plants and dip the ewes as soon as the shearing cuts have healed. At this time the sheep do not carry so much of the solution out of the vat as when the fleece is longer. The general practice in a tick-infested country is to control the parasite by dipping once each year rather than to attempt complete eradication.

Formerly the scab mite was very widely distributed, but quarantine restrictions and compulsory dipping have cleaned it out of a large part of the range country. Sheep infested with the scab mite are irritated and restless and attempt to bite and scratch the infested area. This irritation causes a loss of flesh, and if the mites are not controlled in time the wool falls off in large areas and leaves scabby sores. Because of the weakened conditions, scab-infested sheep have little resistance to other diseases, and much loss occurs. Both the nicotine-sulphur and lime-sulphur dips are effective. To be effective a second dipping must be made at from 10 to 14 days after the first. The Bureau of Animal Industry of the United States Department of Agriculture maintains inspectors in the western range country to direct and supervise dipping operations. Further information in regard to dipping is contained in Farmers' Bulletins 713, Sheep Scab; 798, The Sheep Tick, Its Eradication by Dipping; and 1330, Parasites and Parasitic Diseases of Sheep.

Makeshift vats are often constructed of wood or metal sunk into the ground, but they are generally unsatisfactory because of the labor connected with dipping in them and the fact that they are not usually long enough to allow the sheep sufficient time in the solution. The proper kind of vat has convenient holding pens in front and a chute leading up to a steep incline from which the sheep slide into the vat proper. The vat should be narrow enough to prevent the sheep from turning around, deep enough so that the sheep may be completely submerged, and long enough so that in swimming to the end the animals will remain in the solution a sufficient length of time to kill the ticks or scab mites. At the exit end of the vat a drain should be provided to carry the excess dip draining off the sheep back into the vat. Some method of heating the dipping solution is also necessary. Plans for a dipping vat are contained in Farmers' Bulletin 798, The Sheep Tick, Its Eradication by Dipping.

TRAILING

Because of the increase in settlements and fenced areas, the range sheepman year by year finds his spring and summer range farther from his winter feeding or lambing quarters. This often necessitates long drives with his sheep through lanes and across overgrazed areas where feed and water are scarce. This is the cause of much inconvenience to the sheepman and loss of condition of the sheep. In addition, hungry sheep on a long trail are very likely to eat sufficient quantities of poisonous plants along the way to prove fatal. As much as possible, the sheepman should avoid conditions that will necessitate long trailing.

SUMMER RANGES

Summer ranges vary from the lush weed ranges of the high mountain districts to the Plains areas where there is little difference in the grass the year around, except that it is green in the spring and early in the summer and dry or cured the rest of the year. In the Plains areas handling problems in summer differ very little from those in the spring, fall, and winter except that the necessity for shelter is not so great and in dry districts the amount of country grazed is limited not only by the quantity of feed but by the available water.

In the national forests and other high mountain areas an entirely different method of handling the sheep in summer is used. Grazing on the national forests is under the supervision of local forest rangers, and certain restrictions in regard to bedding down at night, watering, changing camp, and salting are imposed. The common practice is for the herder to direct rather than herd his sheep in an effort to utilize the feed most fully. Under ideal conditions the band moves off the bedground at an early hour in the morning, then scatters out and grazes until it begins to get warm. The sheep water at some convenient place in the middle of the day and then move off into the shade of the timber and rest until it turns cool in the afternoon. In the meantime the herder cooks his food, moves his bed and tepee to the new bedground, and scatters a little salt nearby. Late in the afternoon the sheep begin grazing again and are gradually moved to the new bedground, reaching it just before dark.

An additional advantage is that the feed is not destroyed by being trailed down or its future growth hindered on and near permanent bedgrounds. Experiments conducted by the University of Nevada showed that, in a 100-day summer-grazing period, lambs handled under the bedding-out system were 7 pounds heavier, on an average, at weaning than lambs handled under the central-camp or permanent-bedground system. Seven pounds per head in an average band of 1,250 lambs means 8,750 additional pounds. At customary lamb prices this saving amounts to between $500 and $1,000. The system of changing the bedground frequently and the herder's "bedding out" with the sheep wherever night overtakes them has become a standard practice in the high range country.

In summer, the death losses on the high ranges are ordinarily higher than at any other time of the year, except during lambing. This is due to the rough nature of the country and the prevalence of poisonous plants and predatory animals. Losses, however, may be materially reduced by the watchfulness of a dependable herder.

The time of going on an allotment of summer range is largely seasonal. Forest officials regulate this on the grazing lands of the national forests. In general forage should not be grazed when it is immature, for this practice will seriously hinder the growth in future years. The sheepman should be guided by the development of his forage and allow the animals to graze the lower levels first, thus permitting the later forage on the higher levels to mature. Sufficient forage should be left on the ground to insure reseeding. The time of leaving the summer range will depend on the weather as well as on range conditions and marketing time. In many mountain areas heavy snows fall early in September.

MARKETING

FAT RANGE LAMBS

After the lambs attain the desired finish and weigh from 75 to 85 pounds, the bands are trailed to shipping points, where the lambs are separated from the ewes and sent to market. Most of the fat range lambs are sent to Chicago and other middle-western markets. On their arrival at the market all lambs with sufficient finish are slaughtered, and those lacking the proper finish are sold as feeders and fed until they are fat. The percentage of fat lambs produced on the high mountain ranges, especially of the northern and central regions of the West, varies with the season. Some years it may be less than 50 percent of the lambs marketed and in more favorable years much greater.

FEEDER LAMBS

A very large percentage of the lambs produced in the range country are not sufficiently fat, when weaned, to go directly to the butcher. The more common method of handling these lambs is to sell them for further feeding. Early in the season the grower may contract his lambs at a certain price to be delivered at a specified time. The buyer may be the feeder, but more often he is working on a commission basis and turns the lambs over to the feeder. A few sheepmen feed their own lambs or dispose of them to a local feeder, or they consign them to a commission firm in the central markets which sells to lamb feeders.

FEED-LOT LAMBS

In recent years the practice of fattening western lambs on western feeds has increased greatly (fig. 22), particularly in districts where beet by-products are readily obtained. Many thousands of lambs are fattened annually in Colorado, Montana, Idaho, and other Western States. Beet by-products, corn, barley, and wheat are used, with alfalfa hay supplying roughage. These lambs when handled in the proper manner attain a degree of finish that compares very favorably with the corn-fed lambs of the mid-western feed lots. When fat, these lambs are shipped to Chicago, other central markets, and the Pacific coast.

PUREBREDS

The raiser of purebred sheep in the range country may sell some ewes to other raisers of purebreds, but his main source of income is from rams sold to the range operator. The raiser usually sells these rams as yearlings but occasionally as ram lambs and rams older than yearlings. Private sales and auction sales are the two main ways in which these rams are marketed. Throughout the range country ram sales are held each fall by district, State, and national wool growers' associations. The rams are sold by auction, and in each sale from a few hundred to several thousand animals may be offered.

FIGURE 22.—Lambs in the feed lot. (Courtesy of the State Agricultural College of Colorado.)

SURPLUS EWES

There are two common outlets for ewes which are culled from the flock each year. They may be sold to an operator in the range country who will lamb them early, give them excellent care, and put them on the market with their lambs, or they may be sold in small groups to farmers in the farming sections of the West or Middle West. Under farm conditions these ewes are ordinarily good for another year or two. A few culled ewes are sent to central markets, where they may be slaughtered or resold to middle-western farmers. The number of ewes culled from the herd each year may vary from a very small number to one fourth of the total.

CULLING

The practice of weeding out aged and undesirable ewes from the range flocks in order to keep production to the maximum is a very desirable and necessary procedure. In general all sheep should be disposed of when they do not have a reasonable chance of living through the coming year, of weaning a marketable lamb of good size, or of producing a desirable fleece. The ewe band at breeding time should represent high potential production, and this can be obtained only by severe yearly culling in the fall with a definite standard in view. It has been found practical to cull sheep on the basis of the following factors:

Age.—Age of the ewe influences her production to a marked degree. At the age of 1 year the ewe returns only the wool clip. At 2 years she generally produces a lamb, but lamb production in a flock is likely to be smaller at 2 years of age than for several years afterward since few 2-year-old ewes produce twins. This applies particularly to finewool sheep. After a ewe is about 5 years old there is a tendency for the teeth to become defective, and she is then unable to utilize her feed to the best advantage for her own maintenance and the production of wool and lambs. As the ewe gets older the teeth become uneven, spread, and finally are lost. All ewes should be culled when the teeth first become defective.

Size.—Small, undersized ewes are generally less profitable than those of average or large size, and it is good practice to cull them from range bands. The returns from them in lambs and wool are usually less, and they are not so able to stand the rugged conditions of the range as more robust ewes.

Type and conformation.—For the production of a uniform lamb crop and wool clip it is necessary that the ewes be of uniform type. Ewes with light bones, long legs, poor constitution as indicated by shallow bodies and narrow chests, and other faults of conformation are poor producers, on an average, and should be culled.

Low prolificacy.—The return per ewe depends on the production of both wool and lambs, with the lamb return usually the more important. It is necessary, then, that the ewe raise a fair percentage of lambs; otherwise she will not pay for her keep. A ewe chronically dry or unable, because of spoiled bag or inadequate milk production, to raise and wean a lamb should be culled. The fact that a ewe does not raise a lamb one year is no indication that she will not do so the next, but it is considered good practice to cull a ewe that for two successive years fails to produce a lamb.

Fleece weights.—The fleece production of a sheep is influenced by two important factors—individual differences and environment. To a lesser degree it is also influenced by sickness or other causes that impair the condition of the animal. Experimental evidence tends to show that a ewe producing a light fleece one year probably will do so in succeeding years. Accordingly, it is desirable to cull light-shearing animals from the flock. The culling standards for fleece weight should be based roughly on the average production of the entire flock, and when it is practicable to take fleece weights, those ewes falling far below the average should be disposed of. The number that can safely be culled will depend also on the type of operation and the availability of replacement stock. Practice will enable the grower to cull his light-shearing ewes by examination of the fleece for such factors as length, density, fineness, and shrinkage, when it is not practicable to weigh each fleece. Usually it is not convenient for the range operator to take fleece weights at shearing time.

Fleece quality.—Regardless of the breed or type of animal a desirable fleece should be of combing length for its grade, strong throughout the length of fiber with no marked unsoundness or " breaks ", distinct and regular in crimp, elastic in its stretch, bright or lustrous, moderate in amount of grease, uniform from neck to breech, and light shrinking for its grade. Unsoundness and shrinkage because of dirt are largely due to environment and are not usually the fault of the individual sheep. Fleeces which are short and loose, exceedingly heavy shrinking, and lacking in uniformity, are very undesirable, and animals producing such fleeces should be culled out. Black fibers or kemp and gare hairs (straight, coarse, glossy fibers sometimes found mixed with fine wool) are also objectionable in a breeding flock.

Unsoundness.—Various other causes may make it undesirable to retain sheep in the breeding bands. Cripples, blind ewes, "lungers" (ewes with chronic progressive pneumonia), or other diseased animals have their production ability seriously lowered and for this reason are unfit to retain.

WOOL

There has never been a standard uniform method of marketing the range wool clip. But however it is marketed, the bulk of the yearly clip ultimately arrives at one of the two main wool centers on the Atlantic coast—Boston or Philadelphia. Boston is the largest wool-marketing center in the United States.

A large portion of the western range clip is marketed by consignment to commission houses. These houses may be individual firms or cooperatives controlled by the growers. When the clip is handled through these commission firms, the grower, if he so desires, usually obtains an advance payment before shearing and an additional advance when the wool is loaded for shipment. After the wool reaches the market it is graded and later sold. Interest on the advances and the carrying and handling charges are then deducted from the selling price, and the remainder is sent to the grower. The disadvantage of this system is the fact that on a slow market it may be several months before the wool is sold, and the longer it is held the greater the charge against the clip for storage and interest on the advance payment. However, handling through a cooperative affords the grower some assurance that his product will command its true value. The National Wool Marketing Corporation, which the growers have organized, is endeavoring to aid wool growers in selling their wool. This corporation has headquarters in Boston and constitutes a federation of a large number of State and regional cooperative wool-marketing associations.

When sufficient wool can be gathered together in a lot, either by an individual or by a number of individuals in a pool, it is frequently offered and sold at the highest bid to wool merchants. The wool in these pools may or may not be graded before being offered for sale. Although this local-pool method of selling wool sometimes results in simple transactions quickly completed, it often has the disadvantage of hindering the efforts of growers who are attempting to effect national cooperation in wool marketing.

MARKET GRADING OF WOOL

It requires technical knowledge and many years of experience to determine accurately the market grades and shrinkage of wool; but any practical sheepman can separate the fleeces of his ewes, yearlings, and bucks, and the black fleeces and tags, and further grade his wool within broad limits. The generally accepted market grades of wool officially established by the United States Department of Agriculture are as follows:

Grade:	*Numerical designations*
Fine	64's, 70's, and 80's.
Half blood	58's and 60's.
Three-eighths blood	56's.
Quarter blood	48's and 50's.
Low quarter blood	46's.
Braid	44's.
Common	36's and 40's.

There is a further subdivision of market grades of wool, depending on the length of staple. The longer fiber or combing wools are desirable and often command a higher price on the market than the shorter or clothing wools. Combing wools are used for worsted cloth and the clothing wools for the softer woven woolens, felts, and similar materials.

Shrinkage of wools varies greatly with the fineness of the wool and the type of range on which it is produced. Dirt and sand make up, roughly, three fourths of the total shrinkage and grease the remaining one fourth. Extremely fine wools may shrink from 75 to 80 percent and some of the coarser wools only from 45 to 50 percent. An average shrinkage of western-range wools is about 60 to 62 percent.

Table 1 shows, roughly, wool grades from the various types and breeds of sheep commonly raised on western ranges.

TABLE 1.—*Types and breeds of sheep in relation to the kinds of wool they produce*

Type or breed of sheep	Grade of wool	Classification of wool as to length of staple
Merino	Fine	Strictly combing, French combing, and clothing.
Rambouillet	Fine and half blood	Do.
Hampshire	Three-eighths blood and quarter blood	Strictly combing, baby combing, and clothing.
Suffolk	Three-eighths blood	Do.
Corriedale	Half blood and three-eighths blood	Strictly combing and baby combing.
Lincoln	Low quarter blood, common and braid	Strictly combing.
Crossbred (longwool x finewool).	Half blood, three-eighths blood, and quarter blood.	Strictly combing and baby combing.

The following tentative classification of wool as to length of staple (table 2) has been suggested by the Bureau of Agricultural Economics of the Department on the basis of preferences expressed by many who are engaged in the wool industry.

TABLE 2.—*Tentative classification of wool for length of staple (inches)*

Grade	Strictly combing	French combing	Baby combing	Clothing
Fine	Over 2	1¼–2		Under 1¼.
Half blood	Over 2¼	1¼–2¼		Do.
Three-eighths blood	Over 2½		1½–2½	Under 1½.
Quarter blood	Over 2¾		1½–2¾	Do.
Low quarter blood	Over 3		2–3	Under 2.

The grades Common and Braid are not divided according to length of staple, as they are usually of strictly combing length.

CAUSES OF LOSSES

Losses of sheep and lambs can be reduced by good management, though their total elimination is probably too much to expect. The annual loss of mature sheep, as figured by range men, varies from 5 to 12 percent, depending on the locality and methods of handling. Causes of loss are numerous, but the main ones are poisonous plants, diseases, parasites, and predatory animals.

POISONOUS PLANTS

Large numbers of sheep are lost on the range each year from eating poisonous plants. Most of the loss occurs when, because of a shortage of feed, or because the animals are particularly hungry, they eat larger quantities of the poisonous plants than they do under normal conditions. Sheep that are abnormally hungry from coming off long trails, out of corrals, or after being shipped, often die in large numbers from eating poisonous plants. This also happens early in the spring when sheep are first turned out on the range, as the animals are hungry for green feed. Deathcamas, lupine, locoweed, waterhemlock, chokecherry, bitter rubberweed, Colorado rubberweed, whorled milkweed, and other plants cause severe loss when eaten under certain conditions.

OTHER PLANTS

Foxtail, alfalfa, and sweetclover sometimes cause losses, but they are good feed under most circumstances. Foxtail is a very early grass that has come to supplant better classes of range forage that have been overgrazed. Immature foxtail is a very good feed, and it is only when large quantities of the mature heads are in hay that the damage is great from this source. The beards and heads blind the sheep, pack around the jaws inside the mouth, and, if not removed, cause death. This kind of hay should be scattered on the ground and never fed in racks. The loss caused by grazing alfalfa and sweetclover is due to bloat, when range sheep are turned on pastures. It is generally considered that the danger from bloat is lessened when the pasture is dry and when the sheep are given a fill before grazing pastures of this type. Some small operators graze sheep the year round on alfalfa and sweetclover pastures without abnormal losses from bloat.

DISEASES

Among the many diseases of sheep, necrobacillosis (lip-and-leg ulceration), scours, navel ill, pneumonia, "lunger" disease, goiter, bighead, diarrhea, and the various disorders encountered at lambing time are common sources of trouble and loss. Since sheep do not yield to treatment so readily as most other livestock, the range man should devote his main effort to preventive measures. Sanitation, particularly around sheds and corrals, is a most important measure to be taken in disease prevention. All accumulations of manure and old bedding should be frequently removed from sheds and corrals, and the ground should be allowed to dry out with the aid of fresh air and sunlight. Whenever sheds are constructed provision should be made for as much sunlight as possible, since it is the best disinfectant. Farmers' Bulletin 1155, Diseases of Sheep, discusses the cause, symptoms, diagnosis, and treatment of sheep diseases.

PARASITES

External parasites, including scab mites and various kinds of ticks, are common enemies of sheep. The effect of heavy infestations and their control have previously been discussed.

It is commonly and erroneously supposed that range animals are free from most internal parasites, such as stomach worms, tapeworms, and liver flukes, but post-mortem examinations of large numbers of sheep show that some of these parasites exist, at least in small numbers, in most range sheep. The fact that range sheep graze over a large territory and normally are changed to a new bedground frequently prevents these internal parasites from becoming more troublesome. In many districts in the West where sheep have been confined year after year to small pastures, such parasites give a great deal of trouble. Under these conditions control depends on the same measures that are necessary in the typical farm sheep districts, namely, medicinal treatment and pasture rotation.

Other parasites that give serious trouble on the range during certain seasons when conditions are favorable are the ordinary fly larvae or maggots. In warm, wet springs, from lambing until shearing time and infrequently throughout the summer, maggots are very troublesome. Flies are attracted by, and deposit their eggs in, the dirty wool around the udder and tail head of the ewes, under the horns of rams, and in snagged places and shear cuts on sheep of all classes. Unless maggots are killed by applications of benzol or chloroform and the wound treated with commercial pine tar oil, the trouble may be fatal. In the southern part of the range area the screw-worm fly often causes heavy losses. The attack is induced by any injury such as a shear cut, a scratch or a sore mouth. Since blowflies and screw-worm flies breed in carcasses on the range, burning of dead animals is very important to prevent fly breeding and subsequent infestation of sheep.

Grub in the head is another fly larva that is troublesome under some circumstances. The young maggots are deposited on the nostrils of the sheep and crawl up into the nose and head, where they injure the membranes. Farmers' Bulletin 1330, Parasites and Parasitic Diseases of Sheep, discusses the symptoms, prevention, and treatment of the various parasitic diseases of sheep.

PREDATORY ANIMALS

Wolves, coyotes, mountain lions, bobcats, and other predatory animals, including an occasional stock-killing bear, destroy great numbers of sheep on the western range. All except the wolf are abundant on many national-forest areas, large parts of the public domain, and some private lands.

The coyote, probably the most aggressive of these predators, maintains itself in the face of advancing civilization and presents the major predatory-animal problem on western sheep ranges. Moreover, through the persistent warfare conducted against it by inexperienced individuals in many parts of the West it is becoming so wary of traps that its control is extremely difficult. It is a prolific breeder and in a short time will reinfest an area in which complete control had previously been obtained.

The bobcat also takes a heavy toll from flocks, especially during the lambing season, since lambing is frequently conducted on the open range close to the broken country and rocky canyons that favor its presence. Sheepmen often choose such rough and rugged country, however, for lambing grounds because of the protection it affords against storms.

The chief prey of the mountain lion is deer; but lacking such food, this predator frequently turns its attention to the young of domestic stock, particularly lambs. The severity of its depredations is demonstrated by records in the Bureau of Biological Survey, an extreme example being furnished from western Colorado, where a single mountain lion killed 192 sheep in 1 night.

Bears, which are usually classed as game, are in general not predatory. When an individual animal develops predatory habits, however, it can be the cause of severe depredations to sheep on higher summer ranges.

The gray wolf has now been brought under control in States west of the one-hundredth meridian, though the Department of Agriculture maintains trained hunters to lessen its invasion of private ranges from national forests and other public domain, and at border points where this predator crosses from Mexico to Texas, New Mexico, and Arizona, and from Canada to the northern tier of States. Control of heavy infestations of predatory animals is being made possible by coordinated action of Federal, State, and private agencies under leadership of the Bureau of Biological Survey.

Confirmed sheep-killing dogs are also responsible for much damage. Losses include not only the sheep killed outright but also those that are crippled, those that abort, and those that die of exhaustion. Many western range States have stringent dog laws, though they are not always effectively enforced.

OTHER CAUSES OF LOSS

There are other serious losses to the sheepman that cannot be properly charged to any of the foregoing causes. Some sheep on the ranges die from unknown causes and are never found. Many stray away from the band and are lost. These animals are merely missing at counting time. Many ewes die at lambing time from parturition troubles. A number die each year from injuries caused by careless handling and excessive use of rough dogs. Every sheepman should make an effort to reduce his preventable losses to a minimum; this can only be done by employing reliable herders and giving every possible attention to proper management at all times.

The greatest loss of lambs usually occurs during and just after lambing. Though perhaps not entirely preventable, the loss can be lowered by having the ewes in condition to raise the lambs and by proper facilities and plenty of help during and after lambing.

Constant attention to the care of sheep almost always brings about an increased return.

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U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1711

WHEAT SMUTS AND THEIR CONTROL

CLOUD OF SMUT SPORES FROM THRESHER

WHEAT is subject to a number of smut diseases. The purpose of this bulletin is to describe these diseases briefly, so that they may be identified by the grower, and to give recommendations for preventing them in subsequent crops.

All of the wheat smuts are seed-borne diseases. Three of them—flag smut and the two stinking smuts—also infest the soil under certain conditions. Insofar as the wheat smuts are seed borne, they may be controlled by seed treatment. The spores of the stinking smuts and of flag smut carried on the surface of the seed can be killed by chemicals, such as formaldehyde solution or copper-carbonate dust.

Loose smut, which is carried inside the seed grain, may be controlled by a hot-water treatment which raises the temperature of the wheat high enough to kill the smut but not high enough to seriously injure the seed.

This bulletin is a revision of and supersedes Farmers' Bulletin 1540, Smuts of Wheat and Rye and Their Control.

Washington, D.C. Issued October 1933

WHEAT SMUTS AND THEIR CONTROL

By J. A. Faris, *senior pathologist*, V. F. Tapke, *pathologist*, and H. A. Rodenhiser, *pathologist, Division of Cereal Crops and Diseases, Bureau of Plant Industry*

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LOSSES FROM WHEAT SMUTS IN THE UNITED STATES

WHEAT in the United States is attacked by four smuts—two kinds of stinking smuts or bunts and loose smut and flag smut. The stinking smuts and loose smut are widely distributed in all wheat-growing areas in the United States, whereas flag smut is known to occur only in a limited territory.

Losses from wheat smuts are of two kinds—field losses, which result from reductions in yields, and discounts on the market, because of the foul odor and discoloration of wheat affected with stinking smut.

Estimates made by the United States Department of Agriculture in cooperation with officials of various States show that smuts of wheat cause an estimated average annual reduction of 25,714,000 bushels in the wheat crop of the United States. The estimated annual field losses from these smuts from 1920 to 1930, inclusive, are given in figure 1.

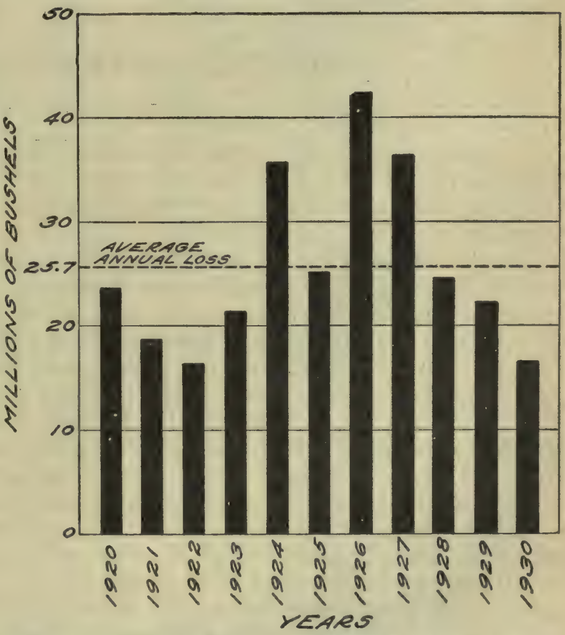

FIGURE 1.—Estimated annual field losses from wheat smuts in the United States, 1920–30.

In the case of the stinking smuts or bunts, which are responsible for about two thirds of the field losses from wheat smuts, the field damage is only a part of the loss. When the stinking smuts are present in wheat to any considerable extent, the foul, fishy odor given off by them permeates the entire mass of threshed grain, rendering it less desirable for flour making. The smut spores also blacken the grain more or less. The smut spores and the odor can be removed only by special cleaning and washing, the cost of which is reflected back to the growers through discounts or, in some sections, by a generally lower price for all wheat in the area. Discounts may run from 3 to 10 cents or even more a bushel. To losses in yield, therefore, must be added the market discounts on account of stinking smut or bunt, which may vary from $45 to $180 a carload, depending upon the amount of smut. The combined field and market losses in the United States, even at moderate wheat prices, amount to well over $15,000,000 annually.

The losses to the wheat farmer from stinking smuts or bunts may be better appreciated if reference is made to the results of a survey made in one county in Nebraska, where detailed records were kept from 1926 to 1930. In this county alone, losses from the stinking smuts averaged $237,590 annually. In 1930 the losses on 1,000 farms in that county averaged $276.87 per farm, or considerably more than the average annual taxes on the 1,117 farms in the same county. If such surveys were made in other wheat-growing areas, it is likely that similar losses would be found.

STINKING SMUTS OR BUNTS

DESCRIPTION

Stinking smuts or bunts are caused by two species of fungi, *Tilletia tritici* and *T. levis*, which are so similar in their characteristics and action upon the wheat plant that they will be discussed together.

The leaves of infected plants show a darker green color than normal at heading time, and, before ripening, the smutted heads also show a slightly darker green color than do the healthy heads. When such smutted heads are examined closely they are found to contain bunt balls instead of grain, and the anthers usually are less conspicuous than those in the healthy heads (fig. 2). The bunt balls are generally shaped like the kernels, but often are shorter and thicker, especially when the wheat is ripe, thus causing the glumes over the grain to spread apart more than is usual in healthy heads (figs. 2 and 3). Smutted plants also are often stunted.

When broken open, these smut balls are found to contain a mass of sooty black powder (fig. 4), the individual particles of which are the reproductive bodies or spores of the fungus. Many of these bunt balls are broken when the wheat is threshed, and the black powder is distributed over the healthy seed. If such contaminated grain is sown without first being treated, particularly if the weather is rather cool, the smut spores germinate at the same time the wheat does, and the parasitic threads of the fungus enter the young wheat

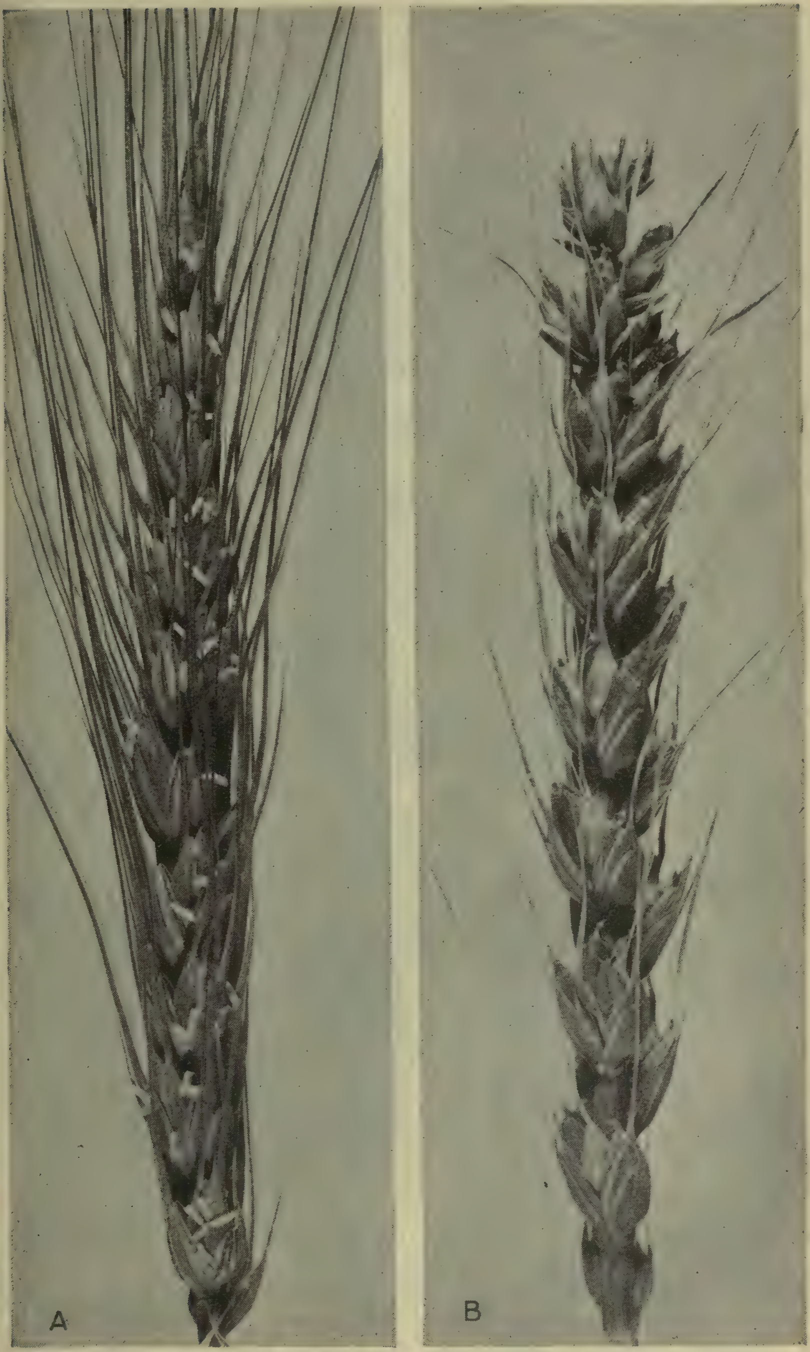

FIGURE 2.—A, A sound head of bearded wheat; B, a bunted head.

seedlings before they emerge from the soil. Once the fungus gets inside the young wheat seedling, it keeps pace with the growth of the wheat plant, and at heading time it forms masses of foul-smelling spores in the heads where normal wheat kernels should be.

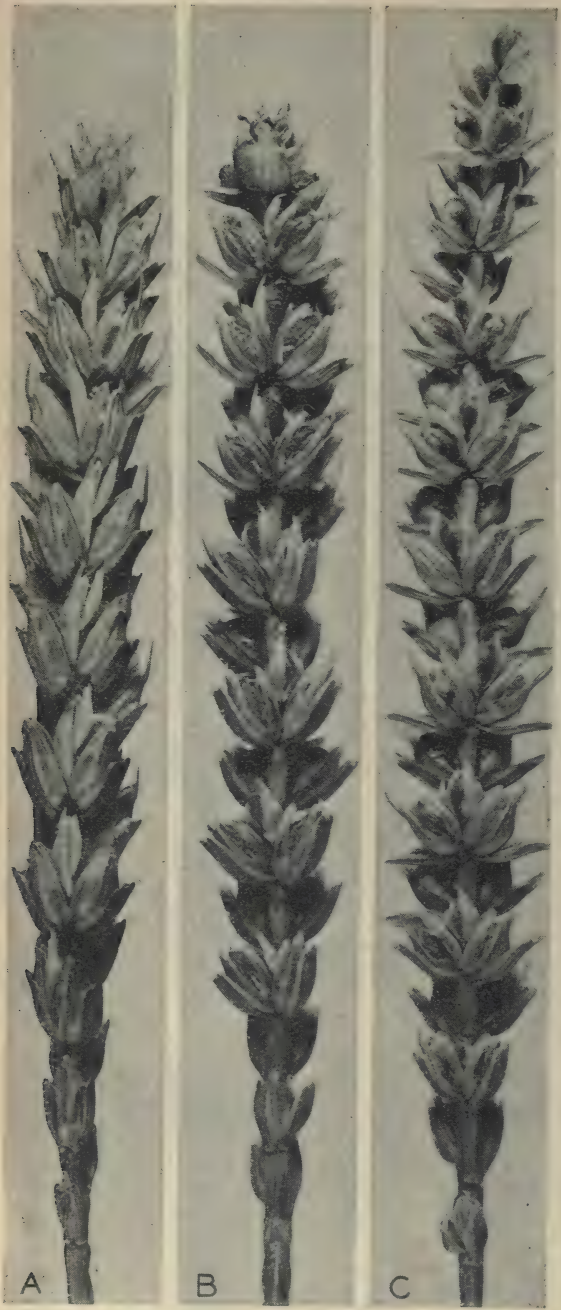

FIGURE 3.—Harvest Queen wheat: A, Sound head; B and C, bunted heads.

CONDITIONS INFLUENCING DEVELOPMENT

Experiments have shown that the stinking-smut fungi can infect the wheat plants much more readily when the soil is fairly cool, that is, when the soil temperature ranges from 45° to 55° F. Sowing wheat in a warm soil would be an effective method of reducing the percentage of these smuts, but the warm soil is unfavorable for the best development of the wheat seedling and also encourages the development of certain other diseases. Early sowing of winter wheat also is favorable for Hessian-fly infestation in many localities. Therefore, in most sections it is not advisable to sow wheat in warm soil.

The free smut spores on the seed may be easily killed by a number of chemicals. Therefore, if the seed grain is properly treated with any one of these effective chemicals before it is sown, the spores on the surface of the kernels will be killed without killing the wheat seed.

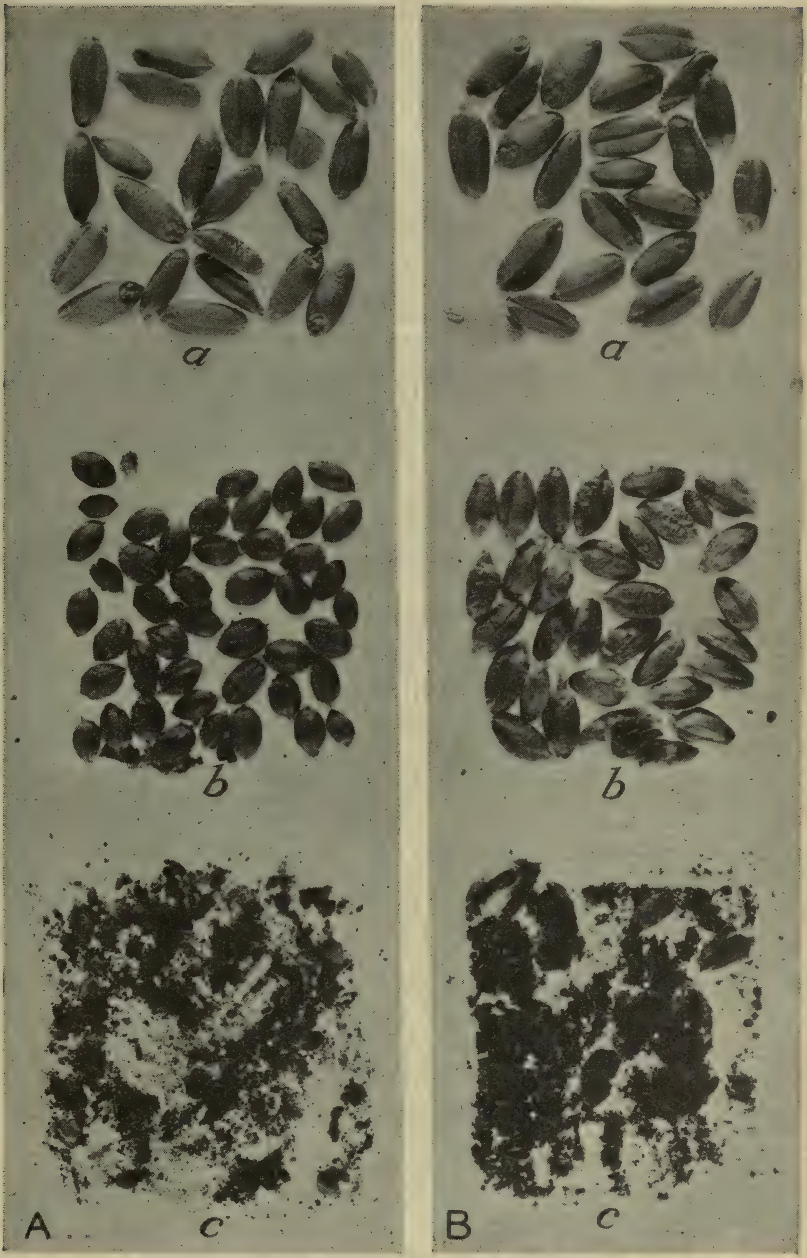

FIGURE 4.—A, *Tilletia tritici* on Kanred wheat: *a*, Wheat grains; *b*, bunt balls; *c*, smut spores. B, *Tilletia levis* on Harvest Queen wheat: *a*, Wheat grains; *b*, bunt balls; *c*, smut spores.

Sometimes the bunt balls are not broken during threshing, because the tough outer layer is a protection. The chemical usually does not penetrate through this layer to the smut spores inside. When these bunt balls are later broken, as they often are in handling the grain or in the drill during sowing, they release live spores of the smut fungus, which may infect the young wheat plants. The unbroken bunt balls and partially smutted grains that are found in nearly all smutty wheat are especially troublesome in smutty durum wheat.

Soil infestation by the stinking smuts presents another difficulty in control. During harvesting and threshing of smutty wheat the bunt balls become more or less broken, and the spores may be blown over the ground where winter wheat is to be sown in the fall, as is shown in the illustration on the cover page. In some localities, especially in the Pacific Northwest and the Intermountain States, where summer-fallowing is almost universal, after the dry harvest season these spores may infest the soil to such an extent that the new crop will become infected, even though smut spores on the seed have been killed by seed treatment. This soil infestation is most common in those wheat areas characterized by a very dry harvest season and where summer-fallowing is practiced. Much of the wheat area where soil infestation is a serious problem is in isolated mountain valleys. It seems possible that the smut in these valleys is of local origin. If this is the case, a concerted use by all farmers of varieties resistant to the local races of smut, together with a seed-treatment program, may lead to practical elimination of the stinking smuts. The date of seeding has a marked influence on the development of smut in the subsequent crop, in that wheat sown in a warm soil may escape infection. A cool soil is most favorable for infection by the stinking smuts, and relatively little infection takes place at 70° F. However, it is not always possible to seed before the soil is cool, because of insufficient soil moisture or other reasons. Smut control is but one factor in the production of a wheat crop, and other factors must be given due consideration in a smut-control program.

No satisfactory control of bunt where soil infestation occurs is known at present. Experiments are now under way to obtain a better knowledge of (1) the local seasonal influences upon infection, (2) the relation of heavily infected fields to the development of smut in the surrounding fields in the following crop, (3) the number and distribution of the pathogenic races of the smuts, and (4) the development of suitable varieties resistant to as many of the races of the smuts as possible.

Fortunately, soil infestation is not likely to be a serious problem in the eastern winter-wheat and spring-wheat areas.

CONTROL METHODS

The most important methods of controlling stinking smuts are (1) the use of clean seed or well-treated seed free of bunt balls and (2) the growing of resistant varieties.

CLEANING AND TREATING SEED WHEAT

Several satisfactory seed treatments have been developed for the control of the stinking smuts. The first important step is to use seed wheat that is as free from smut as possible. Very smutty wheat should not be used for seed because of the difficulty of removing the bunt balls with present methods.

The second step is cleaning the wheat and removing as many bunt balls as possible. The seed wheat should be put through a fanning mill once or twice, as required. If the smut balls are not removed by this cleaning process, the most satisfactory treatment probably will be to use formaldehyde solution in open containers and skim off the floating bunt balls. Those that do not float probably will become sufficiently soaked with the solution to kill the spores.

Two methods of seed treatment are generally employed for the control of the stinking smuts: (1) Dust treatments, in which copper-carbonate dusts[1] and organic-mercury dusts are used; and (2) liquid treatments, in which formaldehyde solution and blue-vitriol solution are used.

COPPER-CARBONATE AND ORGANIC MERCURY DUST TREATMENT

The copper-carbonate treatment has become the most popular of the dust treatments for the following reasons: (1) It does not injure the grain, (2) the seed can be treated somewhat in advance of sowing and stored without injury, (3) dusted seed can be sown at any time in either dry or moist soil, (4) labor and expense of treating wheat for large acreages is reduced, and (5) treated grain is protected from weevils.

Only copper carbonate manufactured for treating seed should be used. This is available in two types. One type contains 52 to 55 percent of metallic copper and is known as pure copper carbonate, and the other type contains 18 to 26 percent of copper carbonate and is known as the diluted form. These dusts should be applied at the rate of 2 to 3 ounces to a bushel of seed. An excessive quantity of the dust will not injure the seed but may tend to clog the drill in humid weather. To be effective the dust must completely cover the seed.

Some of the organic-mercury compounds also satisfactorily control bunt. The dust to be used will depend largely upon the cost. The best way to obtain a thin film of the chemical dust over the entire seed is to mix the grain and dust in a rotary machine made especially for the purpose. Commercial treating machines are on the market, but satisfactory oil drum or barrel mixers may be made on the farm (figs. 5 and 6).

OIL-DRUM MIXER

A 30-gallon oil drum is a convenient size (fig. 5). Cut out half of one head. Bolt to the top of the remaining half a board 1 inch thick, 6 inches wide, and the proper length to fit snugly against the inside rim of the oil drum. Let 1 inch of the cut edge of steel extend beyond the board. Cut a semicircular wooden head to fit the open half of the drumhead and hinge this to the 6-inch strip. If necessary, nail a strip of an old inner automobile tube along the edge of the door to make it dust tight. Attach a hasp to hold the door tightly against the edge of the drum when closed.

The axle is made from ¾-inch pipe, 48 inches long, threaded at one end. It should pass diagonally through the drum, as shown in figure 5, and extend about 8 inches beyond each end. It is best to have the drum and axle welded together, but the axle may be bolted to the drum.

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[1] See U.S. Dept. Agr. Misc. Circ. 108, Copper-Carbonate Seed Treatment for Stinking Smut of Wheat.

Nail or screw a mixing board, 1 inch thick by 6 inches wide, across the full inside width of the drum. Place the board edgewise and about two thirds of the way back from the opening, as illustrated (three nails being shown in each end of the board). Mount mixer on sawhorses.

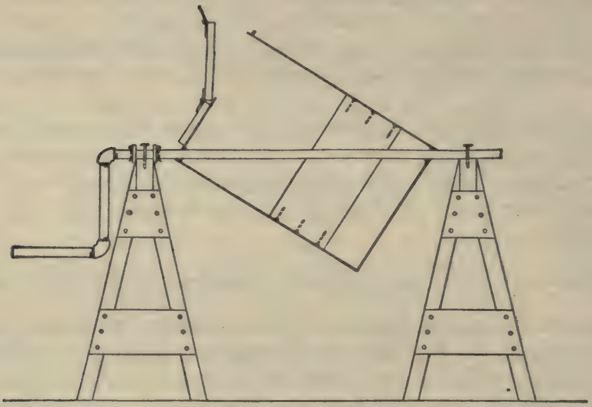

FIGURE 5.—An oil-drum mixer for treating seed wheat with copper-carbonate dusts. (Designed by R. S. Kirby, Pennsylvania State College.)

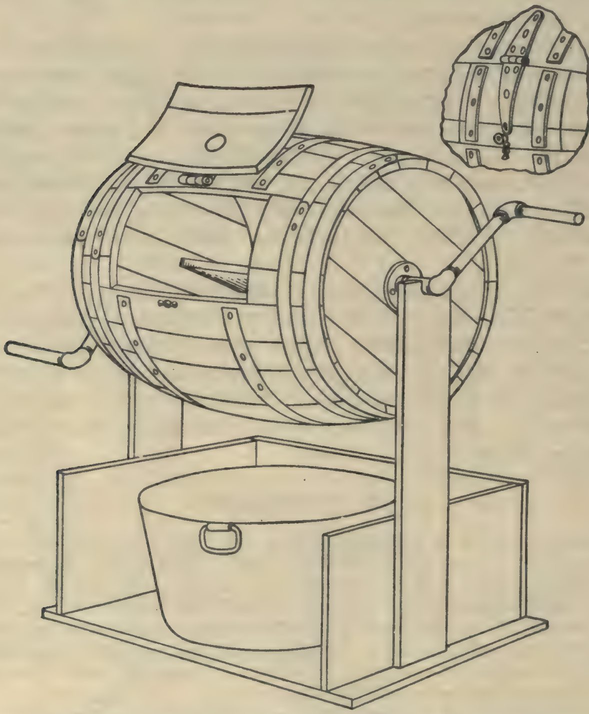

FIGURE 6.—A barrel mixer for treating seed wheat with copper-carbonate dusts. (Designed by F. W. Oldenberg, University of Maryland.)

BARREL MIXER

Use a tight 30- or 40-gallon barrel made to hold liquids. Mark out a door about 8 inches wide by 14 inches long across two wide staves (fig. 6). Fasten hinge and straps to staves before sawing out the door. Saw the staves on a slope toward the middle of the barrel to get bevel edges on the door. Line bevel edges with rubber from an old inner tube to make the door dust tight.

Insert a mixing board 1 inch thick and 9 inches wide along the full inside length of the barrel. Nail it to the ends of the barrel so that it lies edgewise against the inside of the barrel wall opposite the door, as illustrated.

On each end of the barrel screw or bolt a floor or railing flange threaded to hold 1-inch pipe. Insert a piece of 1-inch pipe 6 inches long in each flange to serve as an axle. Use 1- or ½-inch pipe for handles.

Mount the barrel on a boxlike stand, as shown in figure 6, or on sawhorses.

CAUTION

Copper is poisonous.

Wear a mask or a wet cloth or wet handkerchief over the nose and mouth when treating grain with copper-carbonate dust. The treating should be done in a well-ventilated place.

Copper carbonate sifts into all working parts of the drill. After the drill has stood overnight or longer, turn the feed shafts with a wrench to free the feed wheels. This avoids possible twisting of feed shafts and breaking of gears. Oil the gear bearings frequently.

Do not use or sell treated wheat for food or feeding purposes.

Do not mix copper carbonate and wheat in the drill box or by shoveling over on the floor. Satisfactory control of smut is not obtained by these methods.

FORMALDEHYDE SEED TREATMENT

The most commonly used liquid for controlling bunt is a formaldehyde solution made by thoroughly mixing 1 pint of commercial formaldehyde with 40 gallons of water. This should be sufficient for treating about 50 bushels of wheat. If the wheat is free from smut balls, coarse sacks may be half filled with the grain and immersed in the solution for 10 minutes. Care should be taken that every kernel of wheat is wet with the solution. At the end of 10 minutes the grain should be removed from the solution and allowed to drain. Enough seed may be treated the evening before to supply the grain drill the following day.

When the smut balls cannot be completely removed from the seed the treatment should be applied in open tubs, as shown in figure 7, in order to float off the bunt balls.

For treating large quantities of seed one of the commercial seed treaters may be used. These are built to float out the smut balls and wet the seed in a continuous process. For treating small quantities an open tub may be used. The seed can be poured slowly into the solution and stirred at the same time. Most of the smut balls will then come to the surface and should be skimmed off. After about 10 minutes the solution should be drained off through a screened hole at the bottom of the tub. If two such tubs are available the solution may be caught in the second tub and another lot of seed can be soaking while the first lot is being drained and sacked. All sacks should be free from smut to avoid recontamination of the seed.

Several precautions should be taken when formaldehyde solution is used: The solution should be of proper strength; the seed should be sown within 24 hours after being treated; the seed bed should be moist and the rate of seeding increased to compensate for the swollen kernels.

RESISTANT VARIETIES

The breeding of varieties of wheat resistant to the stinking smuts is very promising, but it has been greatly complicated by the discovery of different races of bunt fungi. Some of the varieties considered resistant were found to be resistant to certain races only and susceptible to others. Thus, some varieties bred for bunt resistance were found to develop smut when introduced into localities where other races of smut fungi were present. In such cases, unless seed treatment is practiced, the percentage of smut is usually low at first, but increases each year as the amount of the new race of smut increases in the seed.

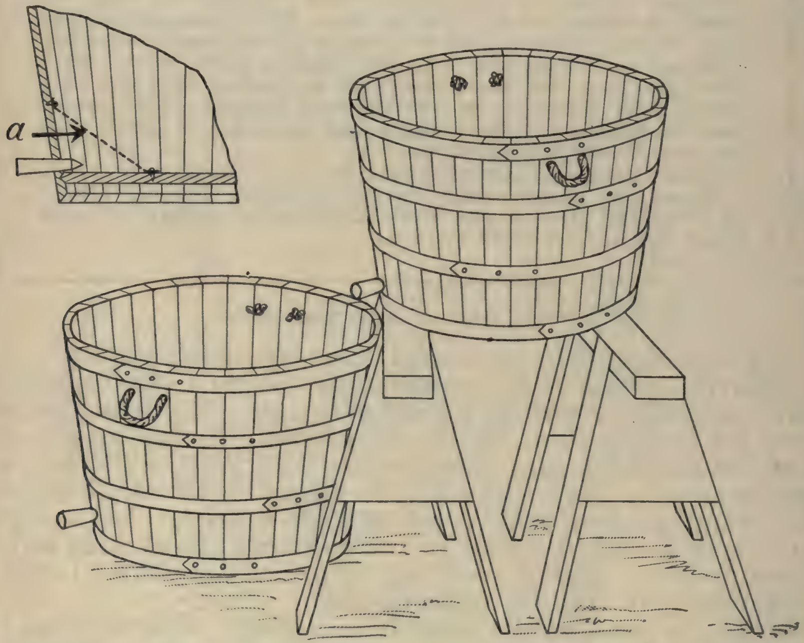

FIGURE 7.—Simple apparatus for applying the formaldehyde soak method of treatment to small quantities of seed. The screen (*a*) is for holding seed while draining off the solution.

Varieties of wheat are being developed which, it is hoped, will prove resistant to most of the important smut races in the localities where they are to be grown. These new wheats may be most useful in the areas where they are being developed, as they are selected for resistance to the races of smut prevalent in that particular area. They may not prove highly resistant in distant localities where they may be subjected to new and different races of the smuts.

It is very important, therefore, to treat the seed of supposedly resistant varieties, in order to prevent the increase of some virulent race or races of the smut fungi which in the beginning may be present in very small quantities.

If resistance were the only factor to be considered in a new variety, the task would be much easier. However, any new variety resistant to smut must also have the other characters desirable for a good wheat in the locality where it is to be grown. It must be a good yielder, produce desirable milling grain, mature at the proper time, be resistant to other diseases, etc.

LOOSE SMUT

DESCRIPTION

Loose smut of wheat, commonly known simply as "smut" or "blackhead", is different from the stinking smuts and flag smut, the other smuts of wheat. As soon as the wheat heads out the smut is very noticeable (fig. 8). The diseased heads are almost completely destroyed by the smut. Instead of normal wheat, chaff, and flowers, black masses of smut, composed of spores of the smut fungus, *Ustilago tritici*, appear along the axis of the head. The spores are easily shaken from the smutted heads (fig. 9) and may be carried for long distances by wind, insects, or other agencies. The greatest distribution of loose-smut spores takes place at about the time the healthy wheat is in bloom (fig. 8). Some of the spores may lodge in the flowers during the short period in which the glumes open in blooming. Here the spores germinate and develop infection threads that grow into the very young wheat kernel inside the chaff. When mature, infected kernels cannot be distinguished from smut-free kernels. However, if such wheat is used for seed without first being treated, the smut fungus inside the seed starts to grow as the kernel germinates, spreading upward into the tender tissues of the plant as it develops. Finally, when the wheat heads appear they are composed of masses of smut. Wheat is infected by the loose-smut fungus only through the flowers. The disease does not infect wheat through the seedlings, as in the case of the stinking and flag smuts.

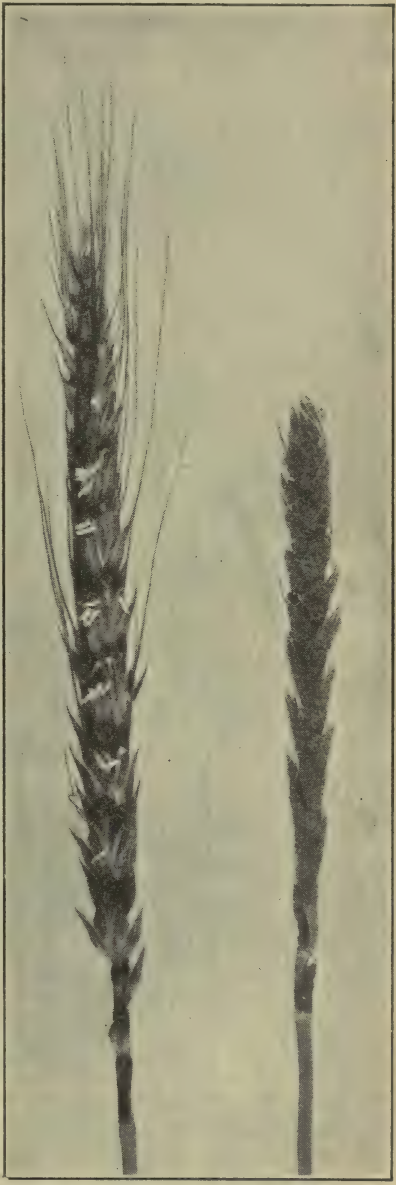

FIGURE 8.—Appearance of loose smut in wheat when the sound heads are in bloom.

CONTROL METHODS

Because the loose-smut fungus is carried inside the seed, it is necessary to apply a treatment that will penetrate the seed and kill the fungus. Surface disinfectants that control stinking smut and other surface-borne smuts will not control loose smut. The hot-water treatment is recommended. If the treatment is properly applied, the heat penetrates the seed and kills the dormant fungus without killing the wheat germ, because the wheat can withstand higher temperatures than can the smut fungus.

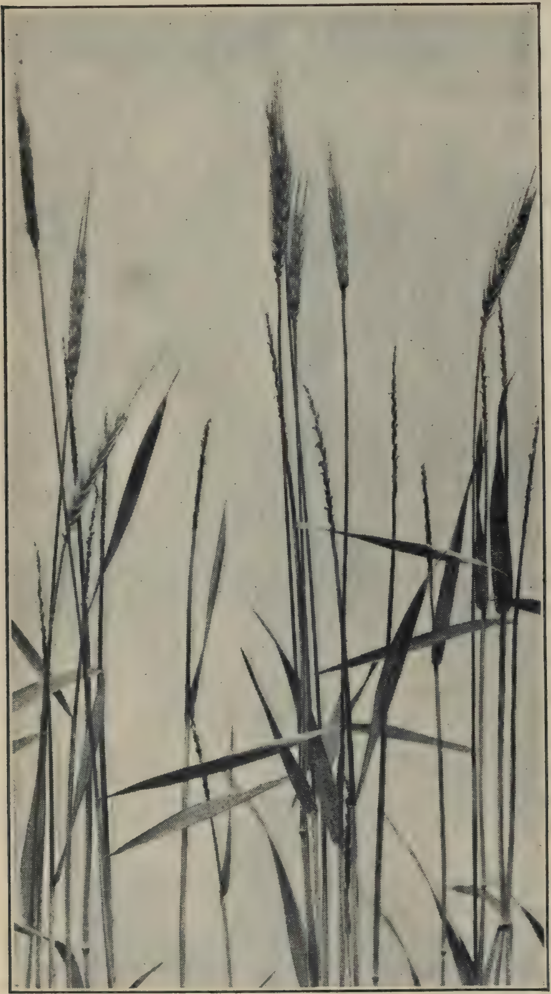

FIGURE 9.—Wheat heads infected with loose smut as they look after the smut spores have been shaken off and the sound heads have begun to fill.

There are two other possible methods of controlling loose smut: To grow resistant varieties of wheat; and, in arid climates where wheat is grown under irrigation, to withhold water during the blooming period.

HOT-WATER TREATMENT

Two different hot-water treatments have been devised, the modified hot-water treatment and the single-bath hot-water treatment. In the former the seed is presoaked for 4 hours in cold water, dipped in water at about 120° F. to warm the seed, and then soaked for 10 minutes in water at 129°. In the single-bath method the long presoaking in cold water is omitted and the seed is soaked for 1 hour and 50 minutes in water at 118.5° or for 1 hour and 35 minutes at 120°. In the 10-minute bath of the modified treatment, and throughout the single-bath treatment, care should be taken to maintain closely the recommended temperatures.

In both the modified and single-bath treatments soaking causes the seed to swell considerably. The sacks used in treating the seed, therefore, should be only half filled and should be tied at the top. Only coarse sacks should be used. During the presoak period of the modified treatment and throughout the single-bath treatment the sacks should lie on their sides and should be turned or rolled occasionally to prevent caking of the swelling seed. Immediately after treatment the seed should be raked out in a thin layer to cool and dry. It is safer to sow the seed after it has been thoroughly dried, but it will run freely through the drill as soon as it is surface dry, when it may be sown. In the latter case the drill should be set at a higher seeding rate to allow for the swollen condition of the grain. Seed that is only surface dry still contains enough moisture to cause germination in a dry soil. If sown in dry soil, some of the seedlings may die and the stand may be severely injured.

The hot-water treatments are not recommended for treating seed for the entire crop, because they are difficult to apply and often cause injury to the seed, particularly when the seed coats have been broken in threshing or otherwise. If seed from smut-free fields cannot be obtained, it is best to treat only a sufficient quantity for sowing a seed plot, and the farther this plot is isolated from fields of untreated wheat the better the results will be. The crop grown on the isolated seed plot from treated seed and successive crops from the same seed lot may remain relatively free from smut, so that further seed treatment will not be necessary for a considerable period. However, reinfection of the seed in the seed plot may take place rapidly. The amount of smut in nearby fields and the influence of climatic factors on its spread and on its development in the wheat flower doubtless play an important part in this reinfection. If the seed wheat to be treated for loose smut also carries spores of the stinking smuts or bunts, the hot-water treatment will control both; but neither the copper-carbonate treatment nor the formaldehyde treatment recommended for the control of the stinking smuts will control the loose smut.

In one of the States, community seed-treating plants for applying the modified hot-water treatment have been established and found very satisfactory. Usually they are managed by the county agricultural agent or by a group of neighborhood farmers. Through the use of treated seed and of seed from crops produced from the treated seed a number of large, relatively smut-free areas have been established. The beneficial effects of the treatment are made more lasting in this way, as the fields within the smut-free areas are mutually protected from infection by loose smut.

CONTROL UNDER IRRIGATION

Loose smut rarely is found in wheats grown on dry land in arid climates. Recent experiments have shown that low relative humidity of the atmosphere during the inoculation period, that is, when the sound wheat heads are in bloom, inhibits the germination of loose-smut spores, thus reducing or preventing infection. Therefore, in arid climates it should be possible to control loose smut in wheats grown under irrigation by withholding water during the blooming period. Thus, the influence of the normally dry atmosphere in preventing infection would be given full play. Details for the practical application of this method of control have not yet been worked out.

RESISTANT VARIETIES

The important wheat varieties of the eastern United States and a few of the most important varieties of the western United States have been tested 2 or more years for resistance to loose smut. Thousands of individual wheat flowers have been inoculated by hand in order to insure infection. As a result, highly resistant or nearly immune strains have been found in the following wheats: Preston (hard red spring common); Bacska, Blackhull, Hussar, Ridit (hard red winter common); Forward, Fulcaster, Leap, Purplestraw, Russian, Sol, Trumbull, and Wyandotte (soft red winter common). These strains have not yet been tested for yield and quality, but if found satisfactory they will become valuable factors in reducing the losses caused by loose smut.

FLAG SMUT

Flag smut has long been prevalent in Australia, where it is one of the most destructive diseases of the wheat crop. Under some conditions this disease often destroys 10 percent of the crop, and losses of one half of the crop are not rare. Flag smut also occurs in China, Japan, India, South Africa, Italy, and Spain.

In the United States, flag smut was discovered in Missouri in 1918. Later it was found in several counties of Illinois near St. Louis, Mo., and in several counties in Missouri and Kansas near Kansas City. Recent surveys indicate that the range of the disease is gradually increasing from these centers of infection.

DESCRIPTION

Flag smut appears as long black stripes running lengthwise on the leaf blades and on the upper parts of the stems of the plants, as shown in figure 10.

Infection in the field usually can be detected by short or more or less dwarfed stalks which seldom produce heads. Usually the entire plant is affected, although partly infected plants are not uncommon in certain varieties. When infected leaves dry, they split along the black streaks and free the black powdery spores of the smut fungus (*Urocystis tritici*). The spores fall to the ground, are blown to adjoining plants, and are spread by the feet of animals and man and by machinery. When infected wheat is being harvested, flag-smut spores are carried to the wheat kernels of uninfected plants. This smut lives over in the soil, or, as is the case with bunt, it may be carried on contaminated wheat seed. Infection of the young wheat seedlings takes place during germination. After entering the seedling the fungus remains inside the plant, but infected plants can be detected by the black streaks on the leaves before the jointing of the plant begins.

CONTROL METHODS

Flag smut of wheat can be controlled by quarantine and sanitation, seed treatment, and the growing of resistant varieties.

QUARANTINE AND SANITATION

Since flag smut is not generally distributed throughout the United States, any material, such as straw, manure, etc., that contains flag-

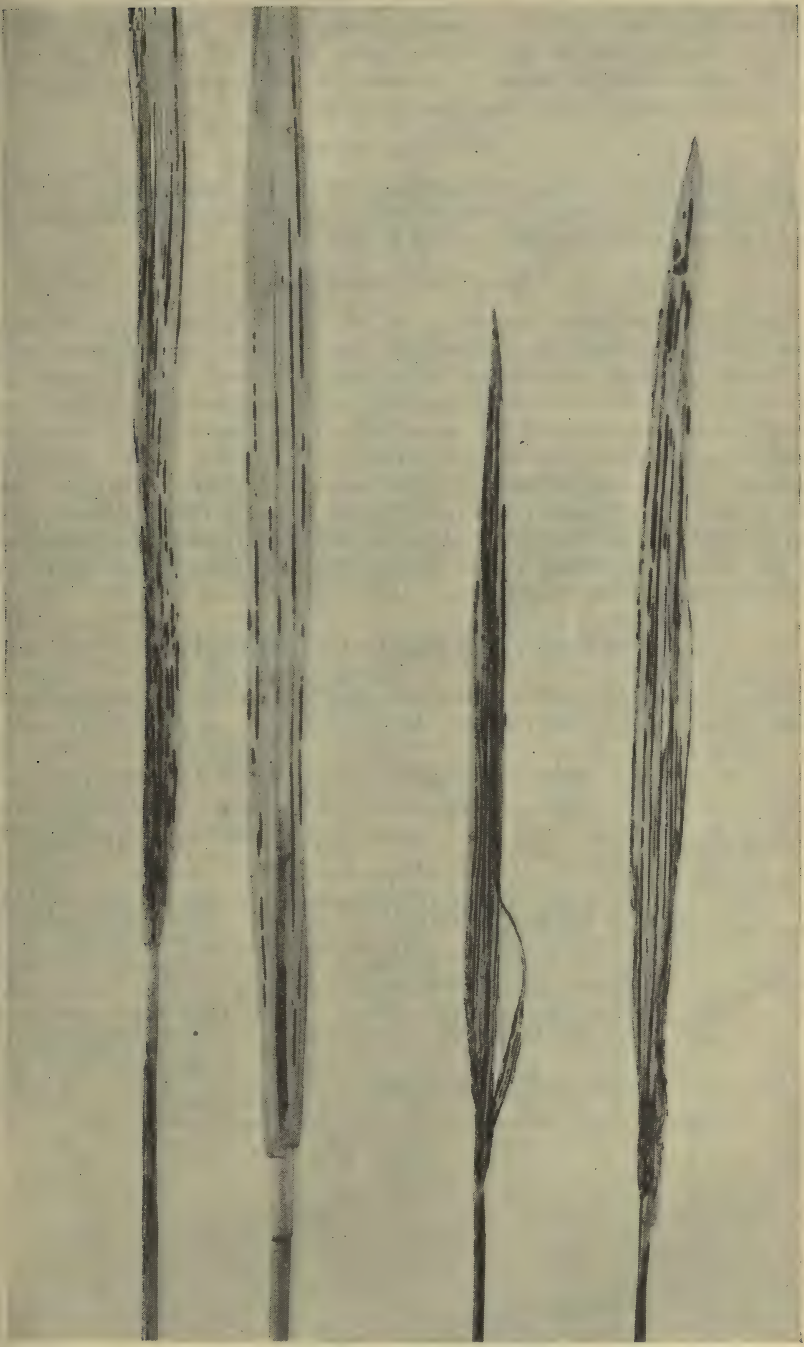

FIGURE 10.—Flag smut in leaves and stalks of wheat.

smut spores may serve as a source of infection and should not be carried to uninfested areas. If such material is to be returned to the land, it should not be applied to fields where wheat is to be sown. Great care should be taken to prevent the introduction of flag smut into States where it does not already exist.

SEED TREATMENT

Seed treatments such as described for the stinking smuts or bunts will effectively kill the spores of flag smut that are carried on the seed but will not affect the spores in the soil.

RESISTANT VARIETIES

The use of resistant varieties of wheat promises to be the most satisfactory method of controlling this disease in infested areas. In experiments in which seed of a large number of wheat varieties was heavily dusted with spores of flag smut and sown in infested soil the plants of many varieties were free from the disease. The most promising resistant varieties commercially grown in the flag-smut areas are Shepherd, Trumbull, Gladden, and Fulhio. Varieties very susceptible to flag smut are Flint, Fultz, Harvest Queen, Jones Fife, and Red Wave. If these varieties are replaced in the flag-smut areas by the wheat varieties found to be resistant, no serious losses are likely to result from flag smut.

SUMMARY OF SEED TREATMENTS

The recommended seed treatments for the control of the different smuts of wheat are summarized in table 1.

TABLE 1.—*Seed treatments for control of wheat smuts*

Kind of smut	Disinfectant	Quantity, strength, or temperature	Duration of treatment
Stinking smuts (bunts)	Copper carbonate (*Caution:* Do not inhale dust).	2 to 3 ounces per bushel	Mix in tightly closed container until each kernel is coated with dust.
	Formaldehyde	1 pint to 40 gallons of water.	Soak 10 minutes, skim off smut balls.
Flag smut	Treat as for stinking smut.		
Loose smut	Hot water (presoak or modified method).	129° F	Soak 4 to 6 hours in cold water, dip in water at about 120° F. for a moment, then soak 10 minutes at 129°.
	Hot water (single-bath method).	120° F	Soak 1 hour and 35 minutes.

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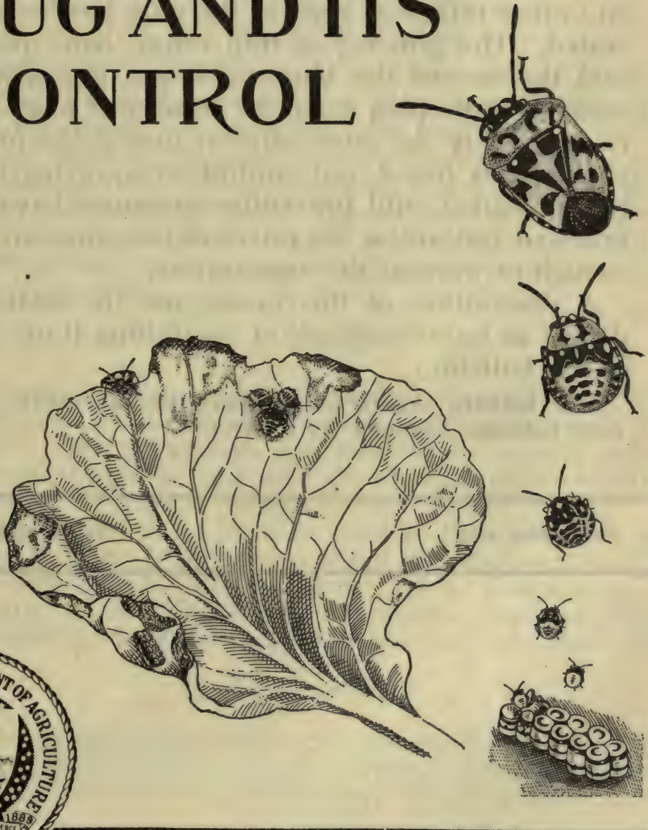
U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1712

The HARLEQUIN BUG AND ITS CONTROL



THE HARLEQUIN BUG is a serious pest of cabbage and related crops in the Southern States. It sucks the sap from the leaves and causes them to wilt and, if the plants are young, to die.

The pest can best be controlled by practicing clean cultural methods throughout the season, and especially by disking and plowing-under all stalks and other refuse as soon as the crop has been harvested. The growing of trap crops, hand picking, and the use of the blow torch are also effective methods of keeping down the number of bugs. Derris extract is the most efficient insecticide for use against this insect, but control by spraying is not recommended until preventive measures have been followed and unless the prices of the crops are high enough to warrant the expenditure.

A description of this insect and its habits and details as to the methods of controlling it are given in this bulletin.

This bulletin supersedes Farmers' Bulletin 1061, Harlequin Cabbage Bug and Its Control.

Washington, D.C. Issued August 1933

THE HARLEQUIN BUG AND ITS CONTROL

By W. H. WHITE, *principal entomologist, and* L. W. BRANNON, *assistant entomologist, Division of Truck Crop and Garden Insects, Bureau of Entomology* [1]

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THE HARLEQUIN BUG has long been a serious pest of cabbage and other crucifers in the southern part of the United States. This brilliantly colored red and black plant bug sucks the sap from the leaves and veins of the plants, causing them to wilt and wither and many of them to die. Severely injured plants appear as though they had been swept by fire, thus giving the insect the popular name "fire bug." It is also known variously as "calico back", "terrapin bug", "cabbage bug", and "collard bug", and to scientists as *Murgantia histrionica* Hahn.

DISTRIBUTION

The harlequin bug is a native of Central America and Mexico. It was first recorded in the United States in Washington County, Tex., in 1864. This appearance was followed by a rapid eastward and slower northward spread over the South, approximately the northern limits for normal damage being reached by 1870. The insect has been found as far north as southern South Dakota, southeastern Iowa, southern Wisconsin, southern Michigan, northern Ohio, northern Pennsylvania, western New York, Connecticut, and Massachusetts, but it is not a pest of economic importance in the Northern States, probably on account of adverse climatic conditions.

FOOD PLANTS

The harlequin bug is primarily a pest of crucifers and readily attacks such plants as cabbage (fig. 1), mustard, turnip, collards (fig. 2), rutabaga, broccoli, kale, cauliflower, radish, chinese cabbage,

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[1] In cooperation with the Virginia Truck Experiment Station, Norfolk, Va.

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horseradish, brussels sprouts, kohlrabi, and rape. Under extreme conditions, such as lack of normal food and heavy infestations, the pest has been known to attack squash, corn, beans, and other vegetable crops not belonging to the same plant family as cabbage. It also feeds and breeds on wild mustard, shepherds-purse, peppergrass, bittercress, rockcress, watercress, sea rocket, bee plant, and practically all other plants of the mustard family.

NATURE OF INJURY

The harlequin bug has sucking mouth parts and obtains its food by piercing and sucking the juices from the leaves and stems of the plants on which it feeds. Shortly after the feeding, white areas or blotches appear about the spots where the insect has punctured the plant tissue (fig. 1). When the insect is abundant and attacks young plants, they soon wilt, turn brown, and die. If larger plants are fed on, stunted growth is often the result (fig. 2).

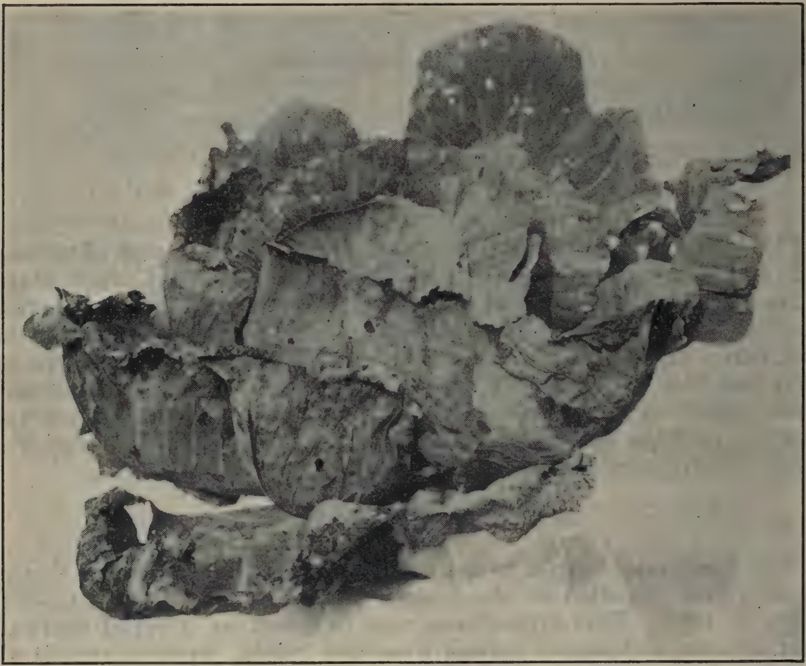

FIGURE 1.—Cabbage plant showing typical harlequin-bug injury. Some of the leaves are wilted and others show the characteristic white feeding areas.

THE DIFFERENT STAGES

The harlequin bug has a very distinctive appearance. It is brilliantly colored and strikingly marked with red or yellow and either black or deep blue. The adult is about half an inch long, flat, and shield-shaped (fig. 3, A).

The eggs are about one twenty-fifth of an inch long. They are pearl gray or pale yellow in color, with two black bands, one near

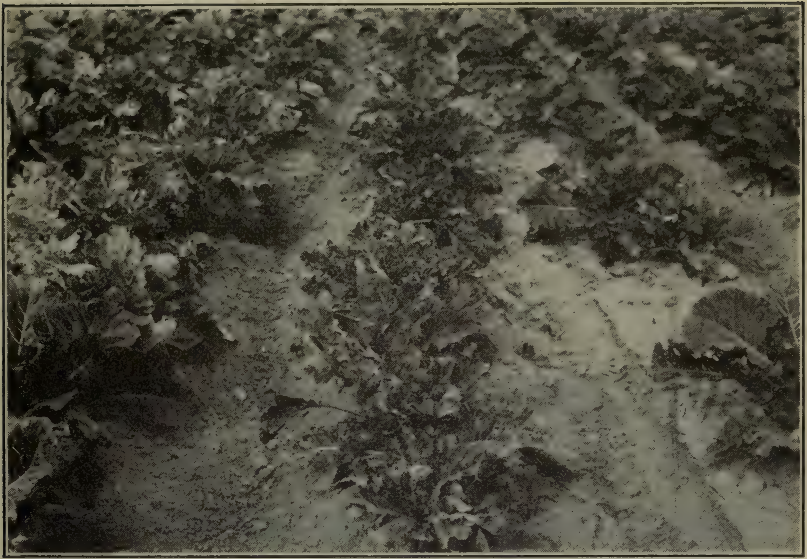

FIGURE 2.—Field of collards showing plants injured by the harlequin bug in the foreground as compared with uninjured plants in adjacent rows. Note wilting and stunting of the injured plants.

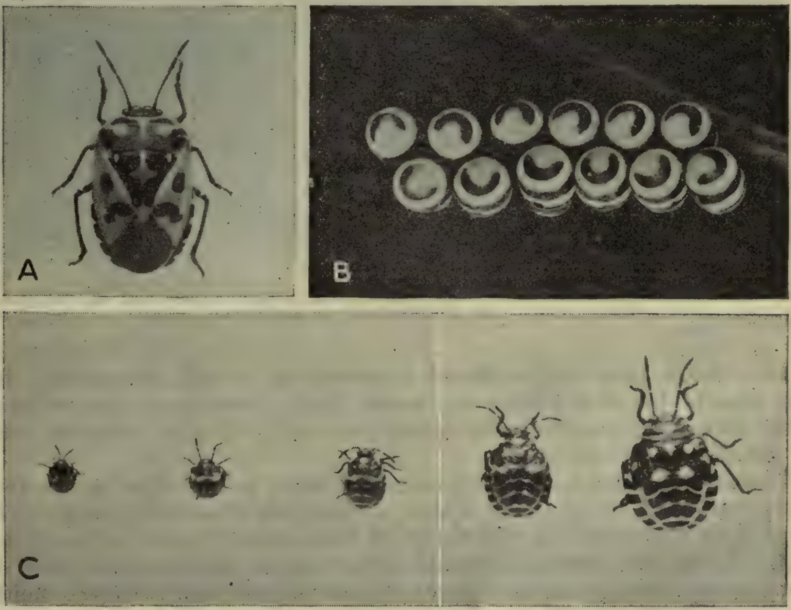

FIGURE 3.—A, Adult harlequin bug; B, eggs; C, first to fifth nymphal stages. Eggs about 9 times natural size; nymphs about 2½ times natural size; adult about twice natural size

the top and the other near the bottom, and with a small black spot just above the lower band. They have the general appearance of small black-banded barrels (fig. 3, B).

The immature stages, or nymphs, are similar to the adults in appearance, except that they are smaller and lack wings. As the young nymph grows, it molts or sheds its skin, passing through five stages before becoming full grown (fig. 3, C).

OVERWINTERING

Throughout most of its range the harlequin bug lives through the winter in the adult stage. As far north as eastern Virginia, during exceptionally mild winters, eggs, nymphs, and adults have been found in the field in February, and farther south the insect may be active during the entire winter.

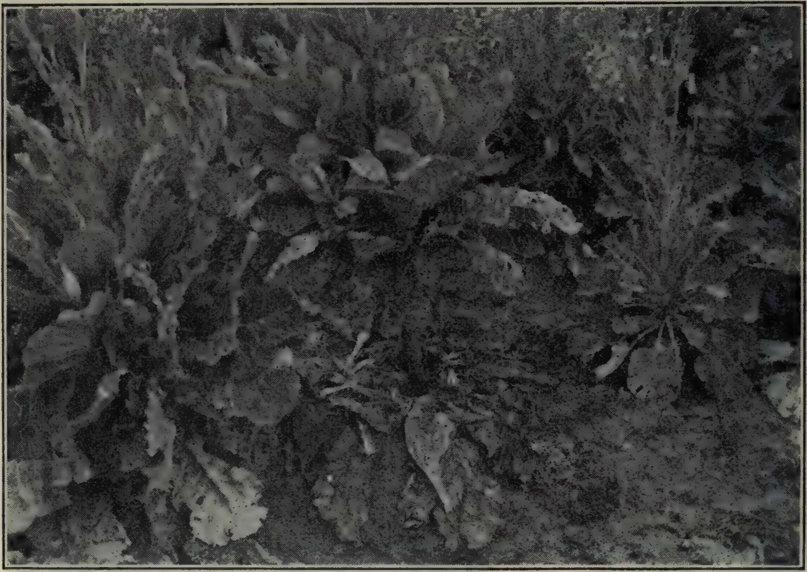

FIGURE 4.—Collard plants, showing an accumulation of dead leaves on the ground. The harlequin bug seeks winter protection in the folds of such leaves and on the ground beneath them. Such plants, for which there is no market, should be disked and plowed under.

In a large part of the South hibernation is only temporary, for the insects become active on warm days throughout the winter. True hibernation apparently takes place only in the northern parts of the infested territory.

In most of the area where normal damage occurs, the insects seek temporary shelter in fields where winter crucifers are grown. The bugs seek protection in the folds of dead leaves beneath the plants (fig. 4), on the ground beneath dead leaves and rubbish, and in bunches of dead grass and other debris in and near infested fields.

LIFE HISTORY

Usually in the early spring the insects leave winter quarters, and all stages may be found in the field during the entire growing season. About 15 days after becoming active in the spring, the adult female begins depositing eggs on the lower surfaces of leaves. The eggs are deposited in double rows of from 10 to 13, 12 being the usual number. A female may lay an egg mass every 5 or 6 days. It has been observed that as many as 187 eggs have been deposited by a single female, while the average number was 115.

Eggs laid in the early spring usually hatch in 15 to 20 days. As the weather becomes warmer the eggs hatch after 4 or 5 days. After hatching, the young, or nymphs, remain congregated about the eggshells for 24 to 36 hours before beginning to feed. In the early spring the complete development from egg to adult may require between 60 and 70 days. In midsummer this period is shortened to between 40 and 60 days. The female deposits eggs within 2 or 3 weeks after becoming full grown.

Some of the individuals that overwintered may live 120 days, but the majority die after about 60 days. The bugs that overwintered usually live longer and deposit more eggs than those of the generations that develop within the active season. The egg-laying period for females that pass the winter ranges from 40 to 80 days.

In most of its range two generations and a partial third occur. Late in the fall, activity is retarded, and general feeding usually ceases by the time of the first frost.

NATURAL ENEMIES

The harlequin bug is remarkably free from parasites and predacious insects. No internal parasite of the insect has been recorded. There are three known parasites of the eggs, *Trissolcus murgantiae* Ashm., *Trissolcus podisi* Ashm., and *Ooencyrtus johnsoni* How.; but, so far as has been observed, they have never become abundant enough throughout the infested territory to serve as a natural means of control of this pest. One of these, *O. johnsoni*, however, appeared to be of considerable value in eastern Virginia during the unusually severe harlequin-bug outbreak of 1932. This parasite was first recorded in eastern Virginia in September 1931, although it had no doubt been present for some time previously. In 1932 it was reared from harlequin-bug eggs collected in the field from the first part of July to the middle of September. During the latter part of August approximately 50 percent of the eggs in some fields were parasitized. As many as three of the minute parasites have been observed to develop in one harlequin-bug egg. It is possible that under favorable conditions this parasite may prove to be highly beneficial in some parts of the South.

One predacious insect, the wheel bug (*Arilus cristatus* L.), has been recorded as feeding on young harlequin-bug nymphs, and another, the leaf-footed bug (*Leptoglossus phyllopus* L.), is recorded as destroying the adult, but these are of slight importance as a means of natural control.

METHODS OF CONTROL

For best results in the treatment of the harlequin bug, preventive measures are necessary, as this insect is exceedingly difficult to combat after it has become numerous on its host plants.

CULTURAL METHODS

The value of clean farming in insect control has long been recognized. This is especially true in connection with the harlequin bug. Crop remnants are often left in the field for some time after harvesting. This is a bad practice, as the insects continue to breed and develop is such fields and easily move over to uninfested plantings nearby. In some sections of the South growers usually leave portions of the kale, and less frequently other cruciferous crops, for the production of seed. They sow these crops during the late summer of one season and gather the seed about the middle of the following season. After gathering the seed, they frequently leave the stalks standing and desert the fields. When prices do not justify harvesting, large acreages of these crops are often abandoned during the winter and spring months, and the fields are allowed to grow up in weeds during the remainder of the season (fig. 5). These practices offer ideal conditions for the development and dispersal of the harlequin bug, as the adults that have sought temporary shelter in and near the fields during the winter remain to breed unmolested during the spring and summer. During midsummer, when food becomes scarce in such fields, the adults fly and the nymphs (or wingless forms) crawl (fig. 6) in large numbers to adjacent fields of young crucifers. Severe infestations on adjoining farms are often traced to such sources.

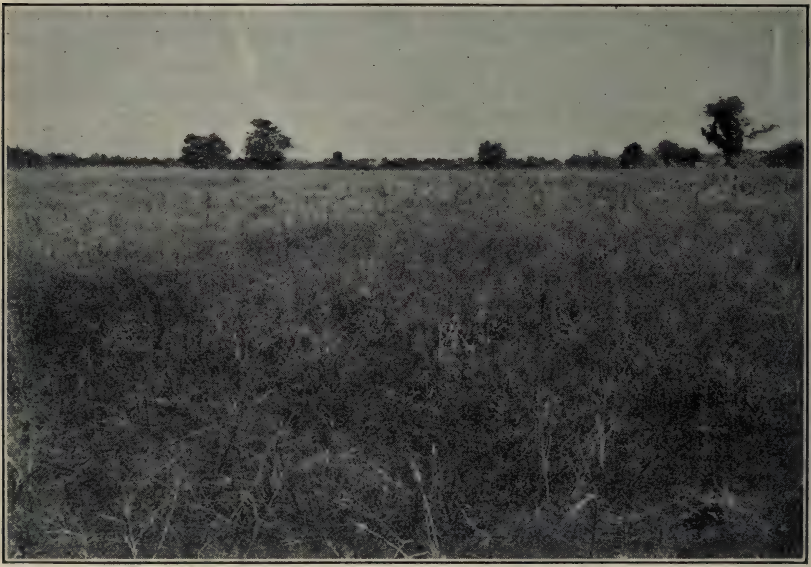

FIGURE 5.—Field of kale abandoned during the winter and left to grow up in weeds. The majority of the plants have dried up, but live sprouts are still plentiful. Large populations of harlequin bugs develop in fields such as this, and when food becomes scarce the adults fly and the nymphs crawl to young crucifers on adjacent farms.

After a commercial crop or one grown for seed has been harvested, or when prices do not justify harvesting, all stalks, plant remains, and other refuse should immediately be disked and plowed under. In cases where cruciferous crops are left in the fields of abandoned farms, cooperative destruction by neighboring growers is highly desirable.

Crawling or migrating nymphs usually enter on one side of a field and attack the plants row by row (fig. 6). When the insects are seen massed on a few rows, its is advisable to disk and plow the heavily infested portions and thus destroy large numbers of the bugs before they are able to do serious damage. It is then important to locate the breeding grounds (fig. 5) and destroy them in the same manner.

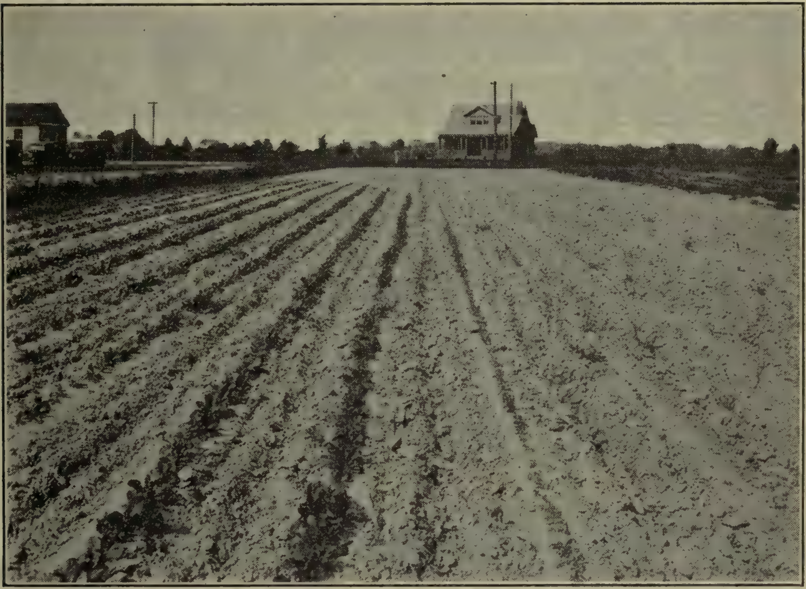

FIGURE 6.—Patch of young chinese cabbage practically destroyed by migrating harlequin-bug nymphs. The nymphs have crawled to this patch from a neighboring abandoned field of crucifers and are destroying the plants row by row.

Wild plants of the mustard family should be carefully kept down throughout the year. A list of such plants is given on page 2.

TRAP CROPS

The growing of trap crops in harlequin-bug control has been practiced for many years. If properly handled, very good results may be obtained by this method. These crops should be planted so that they will be available to the bugs before and after the main crop, the object being to attract the overwintering forms in the spring before the main crop is available and in the fall to concentrate the bugs on a small area. In the spring such plants as mustard, rape, and kale may be utilized as trap crops. They should be planted very early in order to attract the insects from the time they become active until the egg-laying period is over.

In the fall a special trap crop may be planted if all other crops have been harvested and the fields cleaned, or a part of the main crop may be left in the field for this purpose. Since the trap crop must be destroyed to kill the insects, parts of it should be planted on different dates so that a constant food supply will be available.

Trap crops should never be used unless careful attention can be given to destroying the bugs congregated on them. If not properly handled, a trap crop will only serve as a means of breeding more of the insects and thus the purpose for which it was grown will be defeated.

HAND PICKING

If a trap crop is not used, or if a considerable number of the insects escape destruction by this method and appear on the main crop, hand picking of the adults may be successfully and economically done during seasons of normal abundance. The large bright colored insects seem to scorn concealment and are so sluggish that they are easily captured. The insects may be dropped into buckets containing a small quantity of kerosene, or into fruit jars, from which they may be removed and burned.

An example of the ease with which this insect may be hand-picked is taken from the records at Norfolk, Va., during the spring of 1931 From April 13 to May 4 adult harlequin bugs were hand-picked daily in a 0.14-acre patch of broccoli. During this period, 1,288 bugs, or approximately 9,200 per acre, were gathered and destroyed Since the insects tend to congregate in scattered sections of a field individual plants were not closely examined unless one or more bugs were seen crawling about. In this case a thorough examination usually revealed the presence of additional bugs. In this manner it was possible to examine two rows at a time, and to cover an acre in about 7 hours.

Every effort should be made to stamp out an infestation before egg laying begins. The insects usually feed for about 2 weeks in the spring before depositing eggs. During this period the bugs should be hand-picked 2 or 3 times a week, depending upon their abundance, and thereafter as often as is necessary to keep the crop practically free of the pest. When bugs are found on a plant, the under surfaces of the leaves should be examined, and any eggs present should be destroyed by crushing. Any heavily infested plants on which the young, or nymphs, are found should be pulled up and destroyed.

Hand picking should be done during the warmest part of the day. At temperatures below 60° F. the activity of the insects is retarded and many of them seek temporary shelter in the folds of dead leaves or other debris beneath the plants.

THE HAND TORCH

A plumber's blowtorch has proved to be an aid in controlling the harlequin bug. Its chief value is in destroying the insect on trap crops, although an experienced operator may safely apply it to a garden or commercial field of the more hardy cole crops such as cabbage and collards. An instant's contact with the hot flame will so injure the bugs, by scorching the legs and antennae or " feelers ", as to render them harmless and incapable of recovery. The brief contact necessary to accomplish this will not appreciably injure the plant.

In some sections growers use torches made by wrapping an old cloth about the end of a stick and then saturating the cloth in kerosene. Torches have also been made from pine knots.

CONTACT INSECTICIDES

Since the harlequin bug is a sucking instead of a chewing insect, stomach poisons have no effect upon it. In order to kill the insects a contact insecticide must be used and the bugs must be thoroughly covered with the material. This is an extremely difficult task, because the plants upon which the insects feed usually attain such a dense growth that it is practically impossible to reach the insects on all parts of the plant. In some sections of the South where turnips and mustard are sown broadcast for greens an insecticide application is impracticable.

A large number of insecticides have been tested to determine their effectiveness against the harlequin bug.[2] Several of these materials gave excellent results in cage tests, but were found to be inefficient under field conditions. The best results were obtained with derris extract (containing rotenone as the active ingredient and a spreader or wetting agent) at a dilution of 1 to 200.[3] This may be prepared as follows: Use 2 quarts of derris extract in 100 gallons of water or, in smaller quantities, 2 ounces (4 tablespoonfuls) in 3 gallons of water. Measure the quantity of derris extract required to make a given quantity of finished spray, and thoroughly dissolve this in a little water. Then add the dilute derris extract to the quantity of water needed for the finished spray. Agitate the mixture and apply immediately. Mix only sufficient spray for immediate use.

Preliminary tests indicate that commercial dusting powders containing approximately 0.5 percent of rotenone are also of value in controlling the harlequin bug.

It should be borne in mind that only those insects actually hit by the spray are killed. Thoroughness of application is of prime importance.

In treating large crucifers with a hand sprayer it is usually necessary to spray from each side of the row. After thoroughly wetting all visible bugs, it is well to direct the spray to the ground near the base of the plants, as the mechanical motion of the spray rod among the leaves often knocks a few of the insects off the plants.

Control by spraying should be resorted to only after preventive measures to reduce the numbers of the insects have been taken, and when high prices of the crops warrant the expenditure.

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[2] Among the insecticides tested were Japanese-beetle formula sodium oleate-oleoresin of pyrethrum (made in accordance with the method given in U.S. Dept. Agr. Circ. 280, Contact Sprays for the Japanese Beetle), sodium oleate with different proportions of pyrethrum extract, pyrethrum-extract soap with 40 percent nicotine sulphate, several commercial brands of pyrethrum extract, pyrethrum extract with oils, pyrethrum extract with 40 percent nicotine sulphate pyrethrum dust, 40 percent nicotine sulphate, 40 percent nicotine sulphate with activators, nicotine tannate, 40 percent nicotine sulphate with whale-oil soap, 40 percent nicotine sulphate with oils, nicotine oleate, kerosene-nicotine oleate, nicotine-potassium oleate, sodium hydroxide and soap, several commercial brands of white and yellow soaps (with and without 40 percent nicotine sulphate) at strong dilutions, calcium cyanide dust, barium, calcium, and sodium fluosilicates as dusts and sprays, cryolite, sodium fluoaluminate), derris extract at dilutions of 1 to 200 to 1 to 1,200, derris extract at various dilutions with 0.5 percent, 1 percent, and 2 percent soap solutions, and derris extract with whale-oil soap. Derris extract was used in a small series of experiments with white-oil emulsion, summer-strength oils, and tannic acid, and with spreaders.

[3] Entomologists of the Virginia Truck Experiment Station have also obtained very good results with this spray.

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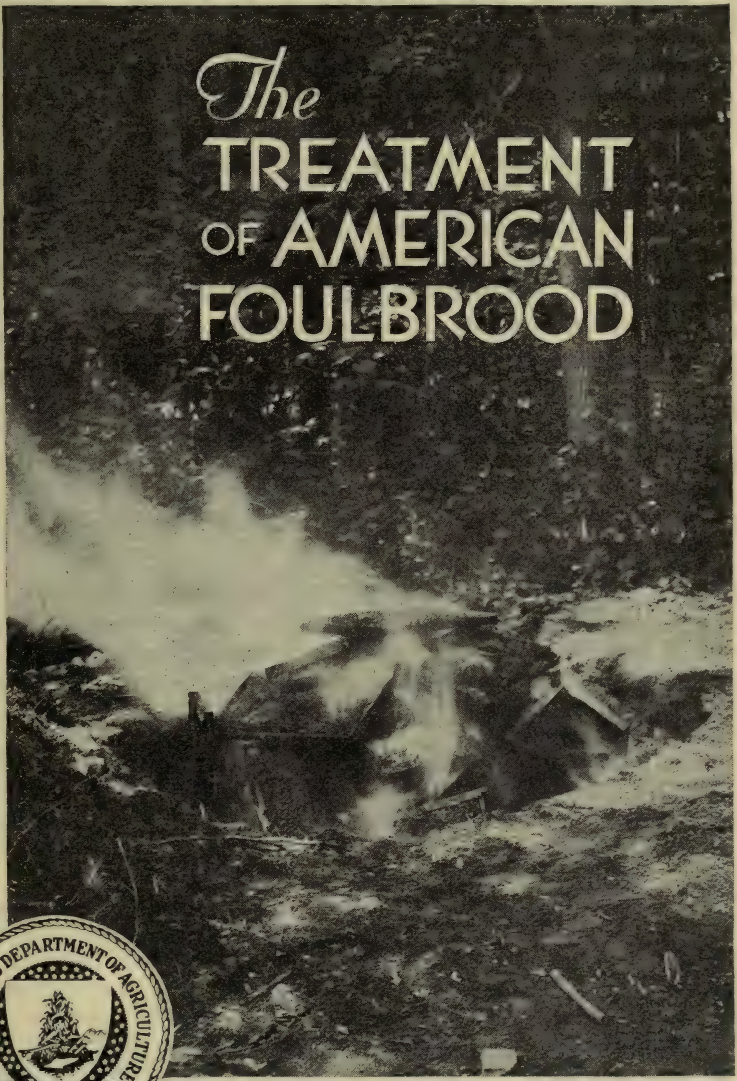
FARMERS' BULLETIN No. 1713



The TREATMENT OF AMERICAN FOULBROOD

AMERICAN FOULBROOD is a disease of the brood of bees which causes serious losses to beekeepers. Its occurrence is practically world-wide, it attacks all races of bees, and strong colonies are as liable to infection as weak ones.

It is important that the beekeeper recognize the symptoms of the disease and be familiar with the manner in which it is spread, in order that he may take precautions to keep it out of his apiary and to prevent it from spreading from one colony to another in case any of his colonies become infected. He should also know how to treat the disease in the most effective way. Such information is given in this bulletin. It is impossible to manipulate colonies so that they cannot contract the disease, but much worry and financial loss can be avoided by dealing promptly and effectively with the disease as soon as it appears.

Samples of brood suspected of being diseased are diagnosed free of charge by the Division of Bee Culture, Bureau of Entomology, United States Department of Agriculture, Washington, D.C.

This bulletin supersedes Farmers' Bulletin 1084, entitled "Control of American Foulbrood."

Washington, D.C. Issued October 1933

THE TREATMENT OF AMERICAN FOULBROOD

By **Jas. I. Hambleton**, *senior apiculturist, in charge, Division of Bee Culture, Bureau of Entomology*

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AMERICAN FOULBROOD is a disease of the brood of bees which causes series losses to beekeepers. Not only does it take a heavy toll in the actual destruction of colonies and increase the cost of operating an apiary, but, what is perhaps of equal importance, the presence of disease in an apiary, or in the vicinity of one, causes such mental anxiety to some beekeepers that it unquestionably prevents them from succeeding in the bee industry.

The disease is practically world-wide in its distribution and is of common occurrence in the United States. All races of bees are susceptible. There have been statements in the beekeeping literature that lead one to believe that the brood of certain strains of bees is immune, but there is no evidence upon which to base this assumption. There may be various strains of the disease, differing in virulence, and individual colonies may react differently. Not enough variation has yet been detected, however, to warrant giving such suspected cases special treatment. Worker larvae are particularly susceptible to the disease, although queen and drone larvae are occasionally affected. Adult bees are immune to it.

CAUSE OF THE DISEASE

American foulbrood is caused by a species of spore-bearing bacteria known as *Bacillus larvae*. The living honeybee larva is its only known host and the disease is transmitted primarily by means of the spores. The bees that work within the hive become contaminated with these spores in attempting to remove the diseased brood, and carry them from one cell to another. Once the disease has spread generally throughout the brood nest, the bees cease trying to remove the dead brood, and it accumulates until the colony dies owing to the absence of emerging bees.

In performing such tasks as feeding the larvae, building the cells, ripening the nectar, and transferring it from one part of the hive to another, the bees may contaminate not only honey that is in the brood nest, but also that in the supers above the queen excluder. This does not mean, however, that all the honey in the brood nest or supers necessarily becomes contaminated.

Spores may come in contact with larvae of any age, but the larvae rarely die until they have developed to the point where they lie lengthwise in the cells or the cells are being sealed preparatory to transformation to pupae. During the early coiled stages the sugar content of the larva is usually high and, since the germ of American foulbrood will not grow in highly concentrated sugar or honey, it is only after much of the body sugar has been utilized that the spores can develop. Underfed larvae have a low sugar content, and in contact with such larvae the spores are able to germinate and to kill the larvae while they are still coiled.

The spores of American foulbrood are invisible to the naked eye, and they are extremely resistant to sunlight, drying, heat, and commonly used chemical disinfectants. The maximum time that the spores retain their virulence has not been determined, but they are known to remain alive for years in honey and brood combs.

SPREAD OF THE DISEASE

It has always been considered that the disease is spread from colony to colony most commonly by the robbing of hives containing disease-weakened colonies or bees that have died of American foulbrood, by bees from healthy colonies. Robbing unquestionably scatters American foulbrood. A disease-weakened colony does not defend itself well; therefore it is possible for robber bees from healthy colonies to help themselves to contaminated honey. On the other hand, the beekeeper himself often unwittingly spreads the disease within an apiary when he moves combs of brood and honey from one hive to another, or unites weak colonies, which may be diseased, with strong, healthy ones. These are probably the most common means of spread. The disease may also be carried from one colony to another when bees enter the wrong hive, a practice generally referred to as drifting.

The dissemination of the disease beyond the range of flight of the bee can be accounted for by the transportation of infected material, including honey, into a disease-free area, where it is later made accessible to healthy bees. Experimental evidence indicates that the commercial shipment of honey is not such an important means of spread as many persons suppose. The sale of used, contaminated equipment is, however, one of the principal avenues through which this disease is spread from one locality to another.

A beekeeper who does not know anything about American foulbrood, or how to check its spread in his apiary, will not be able to maintain his colonies with profit if they become weakened by the disease. Finding this to be the case, he may sell his empty hives, combs, and other accessories, perhaps to another beekeeper who knows no more about the bee diseases than he does. Purchasers of used beekeeping equipment should make sure that it is free from disease material. Some States wisely restrict the sale of used beekeeping equipment to that which is known to be uncontaminated.

SYMPTOMS

In the apiary American foulbrood can be detected only by the presence of brood remains. The spores of the disease organism can be recovered and identified only by bacteriological technic.

The disease may be recognized by the sunken and perforated cappings and the isolated sealed cells in the midst of recently emerged brood. The dead larvae have a melted-down appearance and are usually extended lengthwise in the cells (fig. 1). Occasionally the bees die while in the coiled stage, and in this condition the brood may resemble that dead of European foulbrood. Dead larvae are slightly yellowish or dirty white in color at first, but become chocolate brown or black upon further decay. Shortly after death of the larvae, and until the contents of the cells become too thick, the brood remains can be drawn out with a toothpick into fine silklike threads, and are quite ropy and gluelike. Upon drying, the brood remains, called scales (fig. 1, F, G), become tough or brittle and adhere so tightly to the floor and base of the cells that the bees cannot remove them. The scales are very thin and in old, dark brood combs are easily overlooked.

Pupae that die of the disease undergo similar changes in color and consistency and in the final formation of a scale (fig. 2). Occasionally the tongue of a dead pupa adheres to the roof of the cell. This is a significant, but not an infallible, symptom.

Bees remove many of the cappings from cells containing dead brood, and this makes it appear that the larvae or pupae died before being sealed.

American foulbrood has a characteristic odor, which is pronounced when the disease is in an advanced stage.

Although adult bees are not attacked, loss of brood causes an infected colony to become gradually weaker, and usually to die during the second year of the disease.

The constancy and the uniformity of the symptoms characterize this disease more than does any one symptom. Isolated sealed, sunken, or perforated cells in the midst of healthy emerging brood should be examined whenever disease is suspected. It is not difficult to make a reliable diagnosis in the apiary except perhaps when only 1 or 2 recently dead larvae or pupae are present. In such cases a portion of the comb containing the suspected brood should be sent to a competent inspector. In the meantime the entrance of the suspected hive should be contracted and the colony left undisturbed until the nature of the trouble has been determined.

OTHER BROOD DISEASES SOMETIMES MISTAKEN FOR AMERICAN FOULBROOD

Many colonies have been destroyed or treated in the erroneous belief that they were infected with American foulbrood. On the other hand, the disease has been spread when American foulbrood

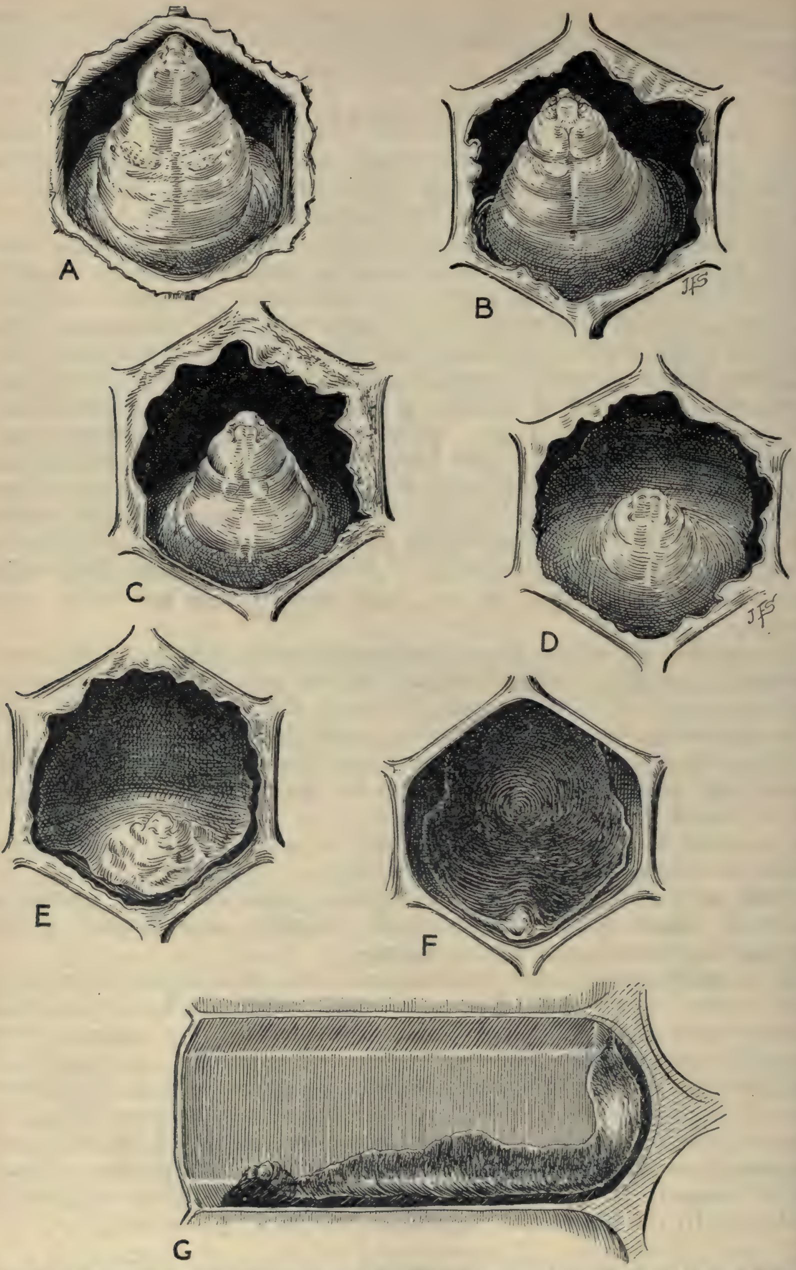

FIGURE 1.—Stages in the decomposition of larvae (prepupae) dead of American foulbrood: *A*, Healthy larva at the age when most of the brood dies of American foulbrood. *B*, *C*, *D*, *E*, Progressive stages in the decomposition of dead larvae. These stages can usually be detected only by removing the cappings. *F*, Scale of American foulbrood. Except in new combs the scale is difficult to see by looking straight into the cell. The comb should be held so that the line of sight falls on the long floor of the cells. This can be done by grasping the comb by the top bar and holding it 8 or 10 inches below the eyes and tipping the bottom bar slightly away from you. *G*, Longitudinal view of an American foulbrood scale.

has been mistaken for some of the less serious brood diseases, which require different treatment. It is therefore of the utmost importance that a correct diagnosis be made before corrective measures are applied. For this reason brief descriptions are here given of the two other common brood disease of the apiary, European foulbrood and sacbrood.

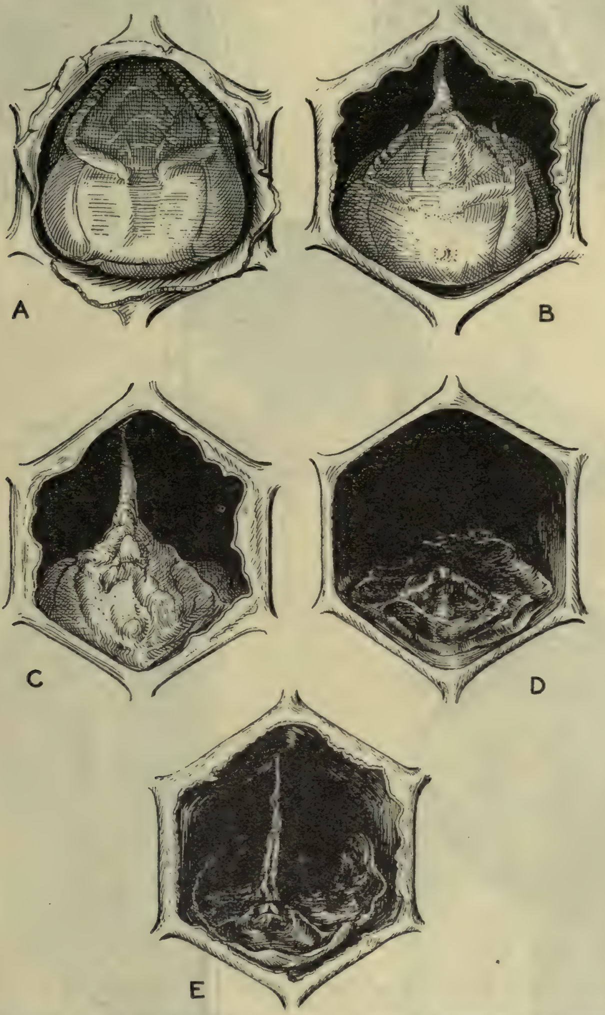

FIGURE 2.—Stages in the decomposition of pupae dead of American foulbrood: *A, B, C,* Heads of pupae showing progressive stages of melting down and decay. In *B* and *C* the tongues show prominently. *D,* Scale of American foulbrood formed from the drying down of a diseased pupa. *E,* Scale of American foulbrood formed from the drying down of a diseased pupa, with a vestige of the tongue adhering to the roof of the cell.

European foulbrood usually kills the larvae in the coiled stages (fig. 3). The dead larvae are slightly yellowish white in color. The brood remains are watery, pastelike, or granular, the appearance varying according to the age at which the larvae die. The scales

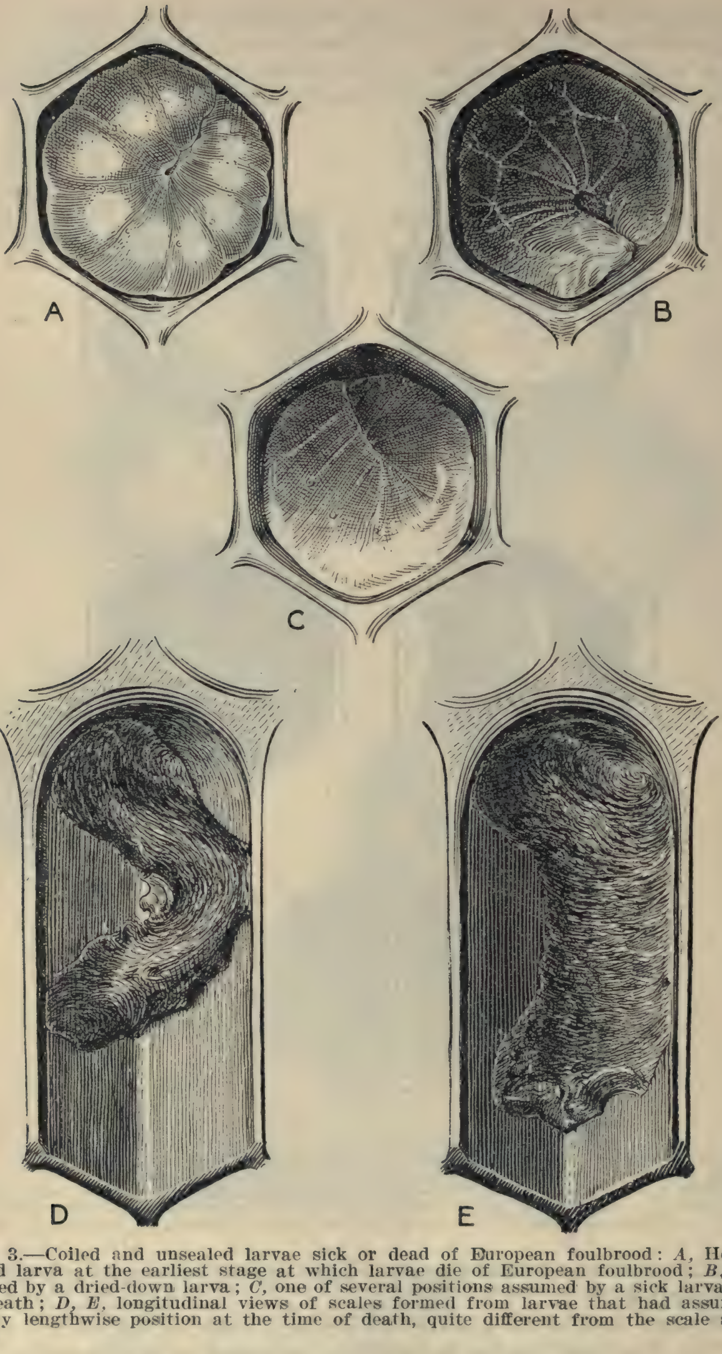

FIGURE 3.—Coiled and unsealed larvae sick or dead of European foulbrood: *A*, Healthy coiled larva at the earliest stage at which larvae die of European foulbrood; *B*, scale formed by a dried-down larva; *C*, one of several positions assumed by a sick larva prior to death; *D, E*, longitudinal views of scales formed from larvae that had assumed a nearly lengthwise position at the time of death, quite different from the scale shown in *B*.

do not adhere tightly to the cells and are removed by the bees in a strong colony. Occasionally larvae dead of European foulbrood become brown and ropy and present other symptoms similar to those dead of American foulbrood (fig. 4). In such cases a correct diagnosis can usually be made only after a microscopic examination.

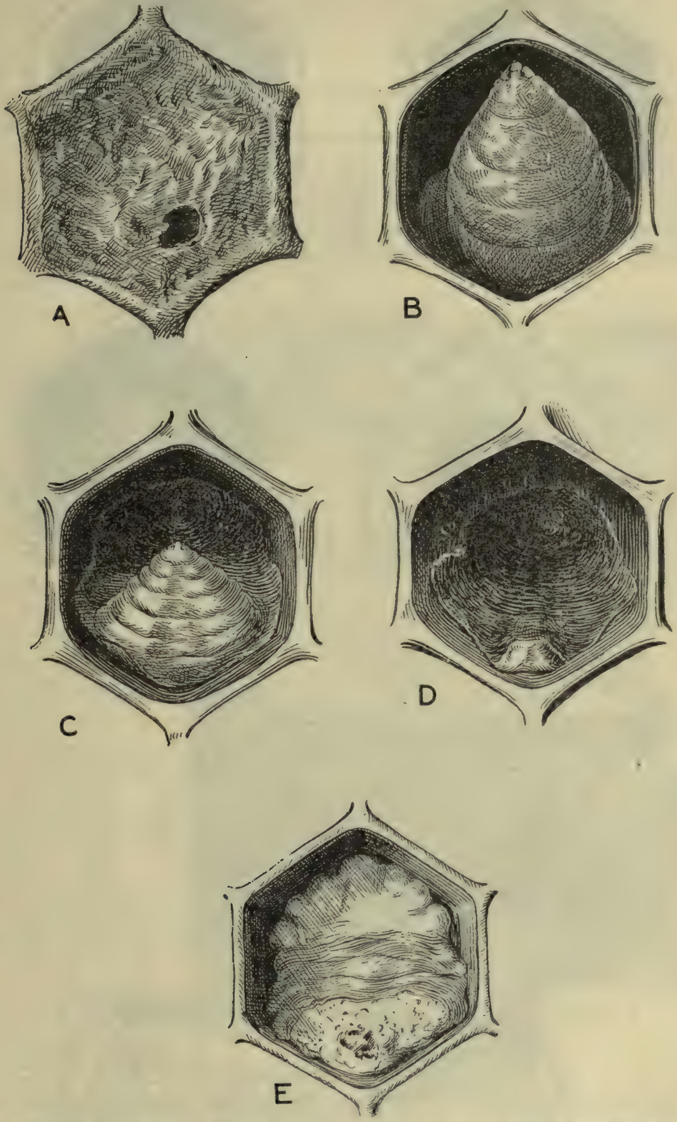

FIGURE 4.—Larvae (prepupae) which may or may not be in sealed cells and which are lying lengthwise at the time of death from European foulbrood. Stages similar in appearance to those illustrated here are encountered in American foulbrood. *A*, Sunken and perforated capping of a cell containing a larva dead of European foulbrood; *B*, larva lying lengthwise in the cell and recently dead of European foulbrood; *C*, same as *B* except in a more advanced stage of decomposition; *D*, scale formed by dried-down larva dead of European foulbrood; *E*, the remains of a larva dead of European foulbrood, part of which has been removed by the bees.

Sacbrood kills the larvae while they are extended in the cell (fig. 5), and the cappings become sunken and perforated, as in American foulbrood. The dead larvae are yellowish at first, but become

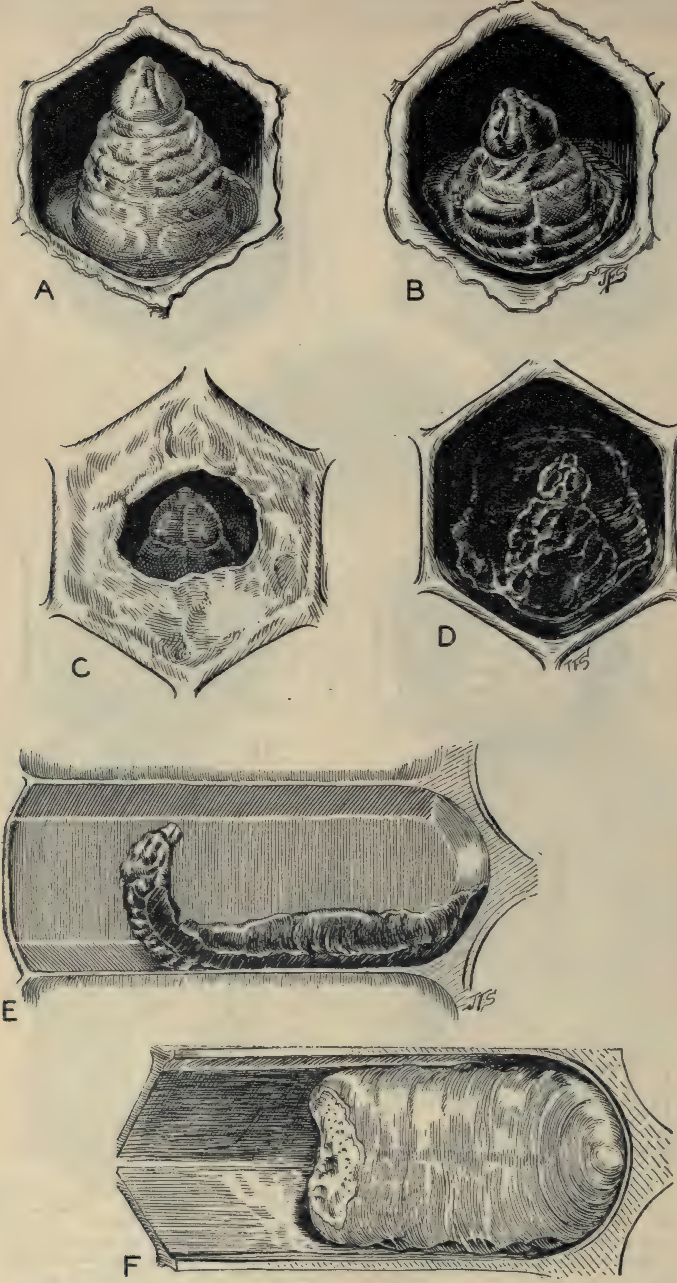

FIGURE 5.—Appearance of larvae (prepupae) dead of sacbrood: *A, B,* Stages in the course of the disease; *C,* the erect head end of a dead larva showing through an opening that the bees have made in the capping; *D, E,* two views showing the scale of sacbrood; *F,* the head portion of this larva has been gnawed away by the bees. Note how the head remains erect in all stages.

brown or black as decay advances. The heads remain erect during the process of decay. The larval skin becomes tough and saclike, thus giving the disease its name, and the material inside is watery and granular. The brood remains do not adhere to the cells; therefore, the bees are able to remove them and the disease does little damage.

TREATMENT

BURNING DISEASED COLONIES

It is now commonly recognized that the safest, and in the end the most economical, means of stamping out American foulbrood is to burn the diseased colonies. While this procedure may seem wasteful to those who believe that less drastic measures afford ample protection, it is the only method that leaves no opportunity for the disease to recur, thus relieving the mind of the beekeeper.

Diseased colonies should be burned as soon as possible after the infection is discovered. Before this is done, however, the bees must be killed. A tablespoonful of calcium cyanide, an extremely poisonous chemical which must be handled with great care, spread on a sheet of paper or cardboard and slipped into the entrance of the hive (fig. 6), which should be left open, will kill the bees in a few minutes. As as an extra precaution additional cyanide may be thrown into the top of the hive, since occasionally the bees fall onto the poison placed in the entrance so rapidly as to prevent the fumes from penetrating all parts of the hive. All field bees that try to gain entrance to the hive will also be killed.

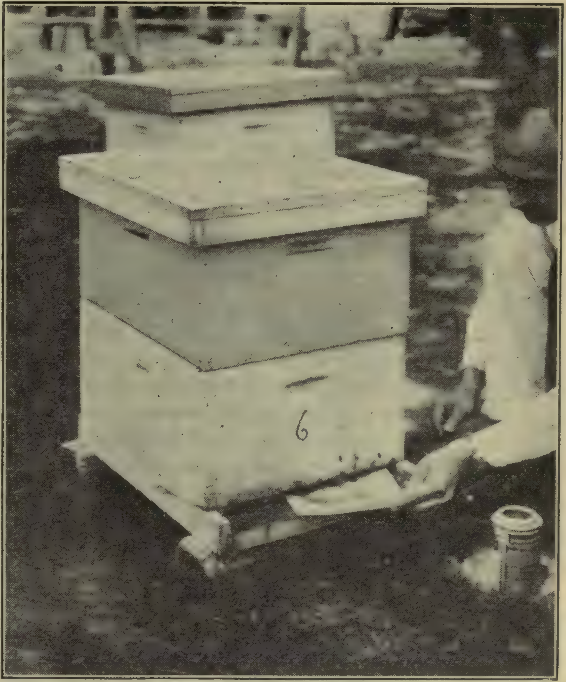

FIGURE 6.—Killing the bees of a diseased colony with calcium cyanide.

Gasoline is sometimes used to kill the bees. In such cases the entrance to the hive is closed, a pint or more of gasoline is then poured over the top frames, and the hive is closed tightly.

After the bees have been killed, the contents of the hive should be burned with the least possible delay in order to avoid trouble from robber bees, as both calcium cyanide and gasoline act as repellents for only a short time.

Before the bees are killed, a pit 18 inches or more deep, and wide enough to hold all the material to be burned, should be dug in a place not likely to be plowed or otherwise disturbed. A hot fire should then be kindled, with plenty of scrap material and with cross members stout enough to support the weight of the frames and placed so as to permit plenty of ventilation underneath. A brisk hot fire is necessary thoroughly to burn the brood and honey.

The hives containing the dead bees should be carried intact close to the pit and the bees and frames fed to the fire as fast as circumstances permit. The bottom board, hive bodies, inner covers, and tops are not burned. By placing the hives on pieces of burlap or stout paper it will be easy to gather up and burn the bits of comb honey or dead bees which may be dropped during the operation. After everything has been completely burned, the topsoil surrounding the fire should be raked into the pit to prevent bees from healthy colonies from having access to any dead bees or honey. The pit should then be filled.

If the killing of the bees and the burning are done at night, the danger of interference from robber bees will be lessened. It is essential, of course, to have everything well planned and all necessary material at hand.

No beekeeper should wait for an inspector to discover and burn his infected colonies, but should, himself, periodically inspect all colonies and promptly destroy every diseased one.

It should be understood that the burning of all diseased colonies in an apiary gets rid only of the colonies in which American foulbrood in an active form is plainly manifest. If there has been any equalization of the brood, if supers or combs have been transferred from one colony to another, or if diseased colonies have been robbed out, it is highly probable that the disease will show up later in other colonies. So even where burning is done carefully and thoroughly, it is usually at least 3 or 4 years before the disease can be stamped out of an apiary.

DISINFECTING EMPTY HIVES AFTER BURNING

After the burning, the hive bodies, bottom boards, inner covers, and tops should be taken into the honey house, thoroughly scraped to remove all propolis and wax, and then scrubbed, both inside and out, with a hot soap or lye solution and a stiff brush. The scrapings should be burned and the wash water disposed of in such a manner that it is not accessible to the bees.

Washing with soap and water is also the best way to remove spores from the hands, clothing, tools, and extracting equipment. Disinfectants strong enough to kill the spores are injurious to the hands.

If it is not feasible to wash the hive bodies, they may be stacked 7 or 8 high to form a chimney, the inside walls sprinkled with kerosene, and ignited. A little ventilation and fuel at the bottom of the stack will produce a hotter fire. Gasoline can also be used for this operation, but extreme precaution is necessary. As soon as the inside is scorched, the fire should be smothered by placing a board over the top super. The outside of the hive bodies should then be thoroughly washed to remove all traces of honey. A gasoline blowtorch is a handy tool for scorching, but its use is rather slow.

SHAKING NOT RECOMMENDED

For many years the Department of Agriculture recommended the treating of infected colonies by the shaking method, whereby the bees in a diseased colony are shaken from the old combs into a clean hive on clean frames. This procedure reduces the losses due to the disease, and a careful operator, who thoroughly understands the disease, may be able to maintain his apiaries in this way. The disease is rarely eradicated by this method, however, and it usually has to be adopted as a routine manipulation. Treated colonies have to be nursed along, and the very act of shaking, if not done with meticulous care, is apt to spread the disease. Moreover, there is always a doubt as to whether the shaking is successful. A treated colony or a colony on disinfected combs cannot be pronounced clean for 2 years. Now, after many years during which colonies have been shaken to get rid of the disease and at the same time save as much as possible in the way of bees and equipment, the disease situation in the United States has not materially improved.

OBJECTIONS TO THE USE OF DISINFECTING SOLUTIONS

Disinfecting solutions are of only limited value in the treatment of American foulbrood. In the first place, their use for treating brood combs does not obviate the shaking treatment, as the bees must be removed before the combs are disinfected. Moreover, the careless handling of combs during the disinfecting operation may result in failure. When disease reappears after a colony has been shaken and later placed on treated combs, it is impossible to tell whether the method of shaking was at fault, the disinfection inadequate, or the colony reinfected.

Although there are several disinfectants which, when properly used, will kill the spores of American foulbrood without destroying the comb, none has yet been found to sterilize the spores in sealed honey without destroying the comb and making the honey poisonous to bees and brood. Individual sealed cells are easily overlooked and it is probable that many, if not most, of the cells of honey in the brood chamber of a diseased colony are contaminated.

Another disadvantage in the use of disinfectants is that bees are loath to accept treated combs, and as a result the size of the honey crop is reduced.

DISINFECTING SUPER COMBS

Disinfectants can be used effectively in treating super combs that have never contained brood. Super combs are ordinarily used on whatever colony needs them and are not set aside for designated colonies. After all the diseased colonies in an apiary have been disposed of, it is often not possible to know whether any of the general supply of super combs have become contaminated by being used on colonies with foulbrood. Therefore, it is safest to disinfect all the super combs in an outfit in which there has been appreciable amount of American foulbrood. This is the only use recommended for disinfecting solutions in connection with the treatment of this disease.

Super combs can be disinfected with a 20 percent formalin-water solution—that is, 20 parts of formalin[1] to 80 parts of water, liquid measure. The combs to be disinfected should be free of honey. They should be kept immersed in the solution at a temperature of not less than 70° F. for at least 24 hours. At lower temperatures sterilization proceeds much more slowly. In order that the solution may come in contact with all parts of the cells, after being placed in the solution the combs should be agitated to dispel as many air bubbles as possible. This can also be accomplished by pouring the solution into the tank so that it rises slowly enough to fill each cell completely.

The 20 percent formalin-water solution may be used repeatedly without much deterioration in strength. It is advisable, however, to add formalin occasionally to maintain full strength of the solution.

Formalin is unpleasant to work with, although not dangerous. It is well for the operator to protect his hands with rubber gloves.

Formalin-alcohol solution, formaldehyde gas, and chlorine also kill the spores of American foulbrood without necessarily destroying the combs. Formalin-alcohol solution, a patented article, is slightly less effective than the 20 percent formalin-water solution and is more expensive. Formaldehyde in gaseous form cannot be recommended for treating American foulbrood combs. The use of chlorine, although still in the experimental stage, has produced disappointing results and, moreover, it is extremely dangerous to handle.

TREATMENT BY STATE INSPECTORS

Under most conditions inspectors are justified in burning every diseased colony immediately, because such a colony constitutes a menace to all healthy colonies in the vicinity. The maintenance of such a serious nuisance as a colony containing American foulbrood should not be tolerated. The best interests of the industry demand the prompt disposal of all such colonies.

When a State inspection force is applying the area-clean-up method for the first time, however, and when the incidence of the disease is high, the use of the shaking treatment is sometimes justifiable. The advisability of using it depends not only upon the amount of disease in a particular apiary or area, but upon the character of the beekeeping, the kind of equipment employed, and the facilities and experience of the beekeepers for doing the job.

Where shaking is used in the first steps of an eradication program, the State inspectors should give every consideration to the protection of healthy colonies. The establishment of temporary yards where diseased colonies can be treated without endangering healthy colonies is strongly recommended in this connection. These temporary yards are not to be confused with hospital yards, which were recommended at one time and with which many beekeepers are familiar. Temporary yards are used only to shake and reestablish the bees in a place where healthy colonies are not endangered. The contents of the hives other than bees should be burned with the least possible delay.

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[1] Formalin or formaldehyde solution is an aqueous solution containing from 37 to 40 percent of formaldehyde gas.

HANDLING AND DISPOSING OF HONEY FROM AFFECTED COLONIES

The honey from a diseased colony, if it constitutes a super or more, may be saved and marketed. The handling of this honey, however, requires special attention. At no time should it be accessible to the bees. Therefore, since no honey house is, strictly speaking, bee-tight, the honey should be bottled or canned as soon as possible, every vestige of honey washed from the outside of containers and from the extracting equipment and honey house, and the empty combs burned. No attempt should be made to recover honey from diseased colonies unless there is a distinct economic saving.

Since it is often impossible to ascertain the source of honey purchased on the open market, such honey should not be fed to colonies of bees if it can be avoided. If such honey has to be used, it should first be diluted with an equal volume of water and boiled for an hour in a closed vessel. Boiled honey, however, should not be fed for winter stores.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1714

CORN CULTURE

1862 1889

CORN is the leading crop in the United States, being grown in every State in the Union on a total of nearly 100 million acres.

Because of its wide distribution it is impossible to give detailed instructions for growing a corn crop successfully. Certain general principles, however, can be laid down which will assist the individual to use methods that are suited to the immediate local conditions.

Varietal names of corn mean little. The important thing in choosing seed corn is to know that the particular strain has yielded well in the locality and that the seed has been handled so as to retain its full vigor and productiveness.

Corn grows best on fertile, well-drained, loamy soils. On poor soils plant growth may use most of the available nutrients, leaving little for the production of grain. To attempt corn growing on unproductive soils is to invite low yields with no profit.

Soils can be improved by suitable crop rotation, the growing of legumes, and the plowing under of green or barnyard manures. These practices, with the supplemental use of commercial fertilizers to supply special needs, can be relied upon to increase acre yields.

Land for corn should not be plowed when it is too wet, should not be plowed and left when excessive soil washing or blowing will result, and should be plowed thoroughly and deep enough to cover trash and vegetation. Thorough final preparation of the seed bed is important, both in promoting profitable yields and in reducing the cost of cultivation.

The principal object in cultivating corn is to control weeds. Cultivation sometimes has other advantages, but these will be provided automatically by cultivation adequate for weed control. Cultivation should be as shallow and infrequent as will control weeds. Additional cultivation is a waste.

This bulletin supersedes Farmers' Bulletin 414, Corn Cultivation.

Washington, D.C. November 1933

CORN CULTURE

By FREDERICK D. RICHEY, *principal agronomist, Division of Cereal Crops and Diseases, Bureau of Plant Industry*

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INTRODUCTION[1]

CORN PROBABLY ORIGINATED in southern Mexico, Central America, or northern South America. Certainly it was unknown to the rest of the world before the discovery of America. Now it ranks with wheat, rice, and oats in world production as one of the four leading cereal crops. About three fourths of the immense total world crop is grown in the United States, where corn is by far the most important single crop, exceeding in production and value wheat, oats, barley, rye, rice, and buckwheat combined. Corn is grown in every State in the Union, about 100 million acres of land being planted to this crop each year (fig. 1).

The concentration of dots in figure 1 shows the importance of the different areas in contributing to the total acreage in corn. Only in the Corn Belt, a somewhat indefinite area in the Central States where the concentration of dots is greatest, does any considerable part of the corn crop leave the counties in which it is produced. Even there the crop is consumed largely on the farms where it is grown, furnishing the bulk of the feed for American livestock.

The largest average acre yield of corn for the United States in any year was 31.5 bushels in 1920. In spite of this, more than 100 bushels per acre have been produced in many parts of the United States. Some large yields have been obtained by methods that are unprofitable or impractical on a large scale. Others, however, have required only such labor and expense as are entirely warranted in practical corn production. These show clearly that materially larger acre yields of corn can be had.

The distribution of the dots in figure 1 indicates also the widely diverse conditions under which corn is grown. The length of the frost-free period, soil type, quantity and distribution of rainfall, temperature, diseases, and the insect pests differ from locality to locality. It is impossible to give detailed instructions for growing a corn crop successfully under conditions that differ so widely, not only from place to place but from day to day. Certain general principles can be laid down, however, which will assist the individual grower to follow methods suited to the immediate local conditions. The State agricultural experiment stations can make many specific recommendations as to corn-growing practices shown by careful experiments to be successful locally. Persons interested in growing corn should by all means write to the experiment station in the State in which they expect to grow the crop for its recommendations as to varieties, rotations, fertilizers, and the better local cultural practices.

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[1] The photograph reproduced on the title page is used by courtesy of the U.S. Army Air Service.

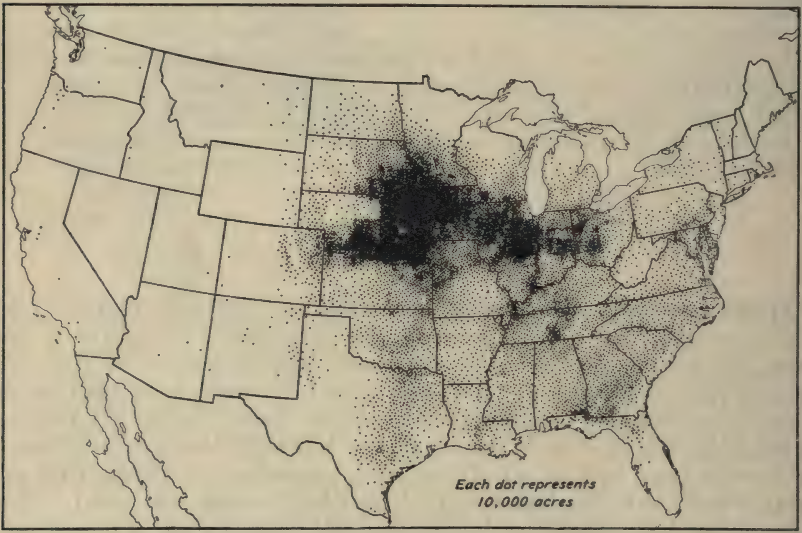

FIGURE 1.—Map showing acreage in corn in the United States, 1929. (Prepared by the Bureau of Agricultural Economics from census figures.)

SEED CORN

Even the most carefully selected varieties of corn are only hybrid mixtures and consequently are changed rapidly by selection under different conditions. For this reason a varietal name tells little about the corn except in a very general way. Thus, Reid yellow dent grown in central Iowa will require several days less to mature than the Reid grown in central Missouri. Similarly, Reid as grown in much of West Virginia is even more quickly maturing and has smaller ears. Again, selection in some States toward the so-called utility type of ear during recent years has created strains of Reid that tend to be longer eared with fewer rows of kernels and with shallower indentation than called for by the standard descriptions of Reid a few years ago. All of these strains properly are called Reid. Any two of them may differ, however, much more markedly in growth habit and yield than Reid and Johnson County white selected by the same grower in the same locality. The same is true of strains of other varieties.

In choosing the kind of corn to plant, the important thing is to know that the particular strain has yielded well in the given locality or under similar soil and seasonal conditions. Most of the State agricultural experiment stations have information as to the better varieties of corn for growing in different parts of their respective States. Furthermore, this information covers strains grown in specific localities, for which reliable sources of seed can be given. Accordingly, those interested in the choice of a variety of corn should write to the agricultural experiment station in the State where they expect to grow the crop for its recommendations as to varieties and sources from which seed can be obtained.

If a reliable producer of seed of the desired variety is known, it will be better for the average farmer to obtain his seed from such a producer year after year unless he himself is willing to make the effort necessary to maintain its productivity. The methods of selecting and caring for seed corn needed to maintain its yielding power are discussed in Farmers' Bulletin 1175, Better Seed Corn, which may be purchased from the Superintendent of Documents, Washington, D.C.

THE SOIL

Other things being equal, corn grows best on fertile, well-drained, loamy soils that are neither too light nor too heavy. It is, in fact, the abundance of favorable corn soil, together with an adequate rainfall, particularly in June, July, and August, that has made the prairies of the Central States the Corn Belt. In addition to the prairie soils, well-drained bottom or second-bottom lands, if not too sandy, and the loess soils are admirably suited to corn production. Many of the Great Plains soils could produce excellent crops of corn if adequate water were available, as is shown by the very satisfactory yields obtained there when corn is grown under irrigation.

Soils that are too sandy and clay soils that are too cold and heavy for successful corn growing may be improved by a suitable crop rotation, by plowing under green-manure crops,[2] or by applying manure. The addition of organic matter in any of these ways not only increases the available fertility but also increases the moisture-holding capacity of sandy soils and lightens and increases the water-absorbing capacity of heavy soils.

Corn is a rich-land crop. It must make a considerable plant growth before any grain is formed. On poor soils vegetative growth may use most of the available nutrients, leaving little for the production of grain during the latter part of the season. Hay or pasture crops are better suited to poor soils. In these crops the entire plant is of value, and yields will be about in proportion to the productivity of the soil and season. In corn, on the other hand, a fair growth of stalk with a low yield of grain profits little. To attempt corn growing on unproductive soils is to invite low yields (fig. 2), and these, with the necessary high cost of production, can mean only losses.

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[2] See Farmers' Bulletin 1250, Green Manuring.

CROP ROTATION

Diversification with an intelligent rotation of crops is essential to a profitable, permanent agriculture. It tends to distribute labor requirements more uniformly throughout the year. This avoids large charges for extra labor during some seasons and provides profitable work for otherwise waste time during other seasons. It also distributes production risks, thereby reducing the chances of total failure. The seasonal requirements of the various crops are quite different, and conditions that may injure one may be beneficial to or not affect another. Possibly one of the greatest benefits from diversification, however, is the opportunity it provides to practice crop rotation.

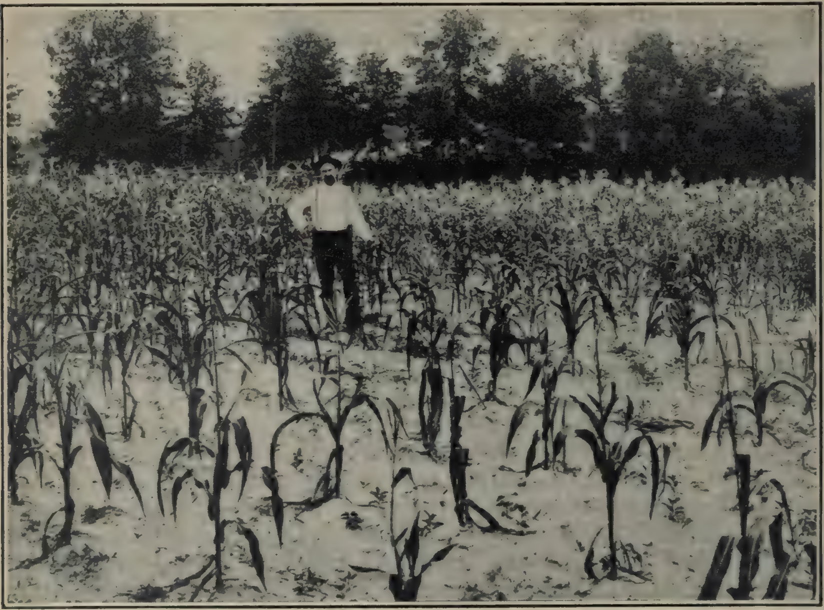

FIGURE 2.—A field in which the soil is too poor for corn growing.

Crop rotation is particularly important in successful corn growing. Because of the costs of cultivation, large acre yields must be obtained if corn production is to be profitable. A good crop rotation helps to better yields in various ways. The turning under of residues from the small-grain, hay, and pasture crops improves the physical condition of the soil and aids in equalizing the water supply of the corn crop. The decay of these residues tends to liberate otherwise unavailable nutrients. If the hay or the pasture crops are legumes, they may actually increase the nitrogen supply of the soil. Finally, a good rotation tends to prevent the accumulation of insects and diseases injurious to corn, thereby reducing losses in yield and quality from these causes.

The best rotation in any case depends upon the crops that can be grown profitably in the particular locality and the type of farming followed. Balanced farming with the feeding of a reasonable number of livestock permits the most satisfactory rotations by utilizing a maximum of hay and pasture crops. In such a system of farming much of the straw and other crop by-products may be incorporated with the manure and so converted into their most effective condition. Cash-crop production, on the other hand, frequently limits severely the choice of rotations to those suited particularly to the needs of the most important crop.

The chief rotations in the Corn Belt are a 2-year rotation of corn and small grain, a 3-year rotation of corn, small grain, and clover; a 4-year rotation of corn, corn, small grain, and clover; and a 4-year rotation of corn, oats, wheat, and clover. The small grain may be oats, wheat, or barley, and red clover or sweetclover may be used, depending upon the locality. The 2-year rotation of corn and small grain, usually oats, can be improved materially by growing sweetclover with the oats, to be turned under the following spring as a green-manure crop. The two successive crops of corn in the first 4-year rotation are more than most soils can stand unless more manure is available than usually is the case. Soybeans in place of part or all of one of the corn crops can be used advantageously where soybeans can be fed or marketed satisfactorily. The second 4-year rotation can be improved by growing sweetclover with the wheat and turning it under.

Probably no crop is more generally beneficial in preparation for corn than alfalfa. Where this crop can be grown profitably, it should by all means be used in the rotation. In some regions alfalfa may be put in and left while the other crops go through 1 or 2 complete rotations on the remaining fields. In other regions the alfalfa may be grown in the regular rotation. In drier regions alfalfa may deplete the soil moisture so much that an attempt to grow corn immediately following it frequently is a dismal failure.

Rotations similar to those used in the Corn Belt are adapted also to the surrounding regions. The proportion of corn in the rotation decreases, of course, as other crops increase in importance, and the alternating crops shift to those best adapted to the given region.

In much of the South corn ranks second only to cotton. Both are cultivated crops and do not supplement each other well in the rotation, making a somewhat similar demand upon the soil. On some of the rich alluvial soils two thirds or more of the land is used for cotton, with corn as the only other major crop. Soil fertility cannot be maintained if these crops are grown exclusively. Planting soybeans in the corn and following this with rye, winter peas, or some other crop to be turned under early in the spring will help to maintain the supply of organic matter. Larger acreages of alfalfa, such as are now being grown on some of these lands, would be highly beneficial in maintaining productivity.

GREEN MANURING

The growing and plowing under of green crops for manure will increase the productivity of most soils in any area.[3] Whether such a practice will be profitable or not, however, will depend upon the particular circumstances. In the North, with a generally more diversified agriculture, an increase in the percentage of legumes for hay or pasture and a better conservation of crop by-products and manure frequently will be sufficient to maintain organic matter in the moderately productive soils. The second crop of clover or the last crop of alfalfa also sometimes may be turned under profitably as a green manure. Sweetclover, grown with the small-grain crop and turned under the following spring, however, probably is the most important green-manure crop in the North and is particularly useful on heavier soils.

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[3] See Farmers' Bulletin 1250, Green Manuring, and Farmers' Bulletin 1663, Winter Legumes for Green Manure in the Cotton Belt.

There are several reasons why the turning under of green manure is a generally more important practice in the Southern States. The decay and consequent loss of organic matter is more rapid than in the North, and continues during the winter as well as the summer, requiring a larger replacement. The winter-grown green-manuring crop serves also as a cover crop and checks winter erosion and the loss of plant food. Finally, more different crops can be grown successfully during the winter, thus making possible selections to fit different cropping systems.

MANURE

Probably nothing will make for large yields of corn as universally as the liberal application of well-rotted manure. Such applications add both needed nutrients, especially nitrogen and potash, and organic matter, thereby increasing the absolute fertility and improving the physical condition of the soil. Within practical possibilities there appear to be no limits beyond which increased applications of manure do not increase corn yields until lack of moisture becomes the limiting factor. On the more productive soils of the Great Plains rainfall is so often deficient that manure may not increase yields enough to pay for applying it in some seasons and may even reduce yields. With a slightly greater rainfall, however, the larger amount of organic matter in manured land will aid in insuring a crop. As the available moisture increases, the value of manure and the quantity that can be used profitably increases.

Although large applications of well-rotted manure usually will increase yields more than small applications, the increase is not proportional. With the restricted supply of manure generally available, it is therefore more profitable to cover a larger acreage thinly than a small acreage with a heavy application.

Well-rotted manure may be applied to land for corn about equally well in the fall or spring unless the soil is quite sandy. On sandy soils manure should be applied in the spring to avoid undue loss from leaching. There is little difference in the effect of well-rotted manure whether plowed under or applied as a top dressing after plowing. The method that best fits in with the general operations of the particular farm accordingly can be chosen.

COMMERCIAL FERTILIZERS

Commercial fertilizers are used to supply 1 or more of the 3 most frequently deficient nutrients, nitrogen, phosphorus, and potash. They often may be used to good advantage to supply a specific deficiency and to supplement the natural productivity of the soil. Corn cannot be grown profitably, however, on soil so poor that most of the nutrients used by the crop must be supplied by commercial fertilizers. The kind and amount of commercial fertilizer that can be applied profitably on any field will depend upon the original nature of the soil and the way it has been farmed previously. The best specific treatment can be determined only by actual trial. More or less haphazard experiments with fertilizers by individual farmers are likely to be costly. The recommendations of the State agricultural experiment station as to fertilizer treatments likely to prove profitable under local conditions should be obtained. The following brief general discussion is limited to fertilizers that are used most widely for corn and to those that are applied primarily to benefit the crop immediately.

Nitrogen fertilizers promote quick and vigorous growth of stalks and leaves. The nitrogen supply of the soil generally can be maintained more economically by turning under legumes such as cowpeas, clover, alfalfa, and the like. Nitrogen fertilizers, such as nitrate of soda or ammonium sulphate, sometimes may be used to advantage to supplement this supply. On thin soils and on soils that are inclined to be cold and wet, an application of nitrogen at planting time will promote a more rapid growth.

A lack of available nitrogen may be indicated by slight plant growth and by the foliage being light green or yellow-green. The presence of available nitrates is shown by a luxuriant growth of dark-green plants.

Nitrogen deficiency usually is more frequent in the South, where the longer periods of warm weather promote rapid nitrification and subsequent loss. Here it may sometimes be desirable to use some of the organic nitrogenous fertilizers, such as cottonseed meal or tankage. These become available to the plants slowly, and their effect therefore lasts during most of the season. They are expensive, however, and it is preferable to add nitrogen by applying manure and by turning under legumes.

Phosphatic fertilizers tend particularly to increase the yield of grain. Bone meal is an excellent fertilizer of this type, but its high cost ordinarily makes its use for corn production impractical. Superphosphate is the most practical form in which to apply phosphorus for immediate utilization. This may be applied after the ground is plowed and ready for planting. It may be broadcast, or applied in the row or in the hill, or both.

Extreme deficiencies of phosphorus, especially on acid soils, are indicated by stunted plants and generally unprofitable yields. Other soils may not contain enough phosphorus for maximum grain production, although containing enough for normal plant development. The only evidence of this condition is the failure to obtain grain yields in keeping with the size and vigor of the plants.

Throughout the Corn Belt, except on a few soils, lack of phosphorus is more likely to be a limiting factor in corn production than lack of either nitrogen or potash.

Potash fertilizers contribute generally to the health of the plants and quality of grain. Both muriate and sulphate of potash, containing about 50 percent of potash, are good sources. A deficiency of potash frequently is indicated by broken or leaning stalks and rotted roots. Peat and muck soils are especially deficient, and suitable applications of muriate or sulphate of potash to such soils, together with some superphosphate, usually will pay profitable returns. Sandy soils also are likely to require potash. Clay soils and loams are unlikely to be deficient in potash, and, if the supply of organic matter in such soils has been maintained, and particularly if reasonable quantities of unleached manure are available, such soils rarely will require additional potash.

Mixed fertilizers often may be used to advantage. It is important, however, to know that the fertilizer selected provides the elements needed for the particular case. Thus, superphosphate frequently will be profitable on land that has been well farmed and manured, where the addition of nitrogen and potash would be money wasted. On peats and mucks potash usually is the limiting factor, and the fertilizer selected should supply particularly an abundance of this element. On sandy and other light soils a complete fertilizer may be most profitable.

It should be emphasized again that nothing will do more to insure profitable yields than maintaining an abundant supply of organic matter. This will aid in making available the various nutrients already in the soil, and will assist water absorption and aeration during periods of excess rainfall and tend to check moisture losses in times of drought. Supplementing this by the intelligent application of commercial fertilizers, particularly so that they will be available at periods of special demand, will promote the most profitable yields.

APPLYING FERTILIZER

Field experiments in many parts of the country during the past few years have demonstrated that the application of commercial fertilizers in the row, or, better still, the hill, is generally more efficient than broadcast applications. Even on fairly productive soils there frequently is a period shortly after planting when the available nutrients near the young corn plants are insufficient to support the most rapid development. On less productive soils this condition is more general and more serious. The application of commercial fertilizer in the hill will get the plants off to a good start. The rapid early development of hill-fertilized corn is reflected in quicker maturity and frequently in a decidedly better crop quality in addition to any increase in yield. In dry areas, particularly on productive soils, the use of commercial fertilizers sometimes decreases yields by promoting a larger growth than the later moisture supply can support.

Fertilizers applied in the hill should not come in contact with the seed. The ideal method appears to be that in which the fertilizer is placed in a broad band on each side of the seed. Several of the commercial corn planters have been modified during recent years so that they achieve a safe and efficient placement. The essential features necessary for correct placement are (1) a deflector to spread the fertilizer stream to the two sides of the seed, and (2) a hood over the corn-planter shoe to hold back the soil until the fertilizer has reached the bottom of the furrow. Fertilizer improperly placed in the hill may cause poor stands and actually lower yields, whereas the same amount properly placed would have been beneficial.

On reasonably productive soils that have been well-managed, it should be unnecessary to use more nitrogen or potash than can be carried in a safe hill application. It frequently will be desirable, however, to apply additional superphosphate to soils in which the nitrogen and potash supply has been maintained by manuring. If so, the additional superphosphate may be drilled in broadcast before planting, as excessive hill applications are unsafe.

PREPARING LAND FOR CORN

Except where corn is to be listed, the first step in preparation is plowing. Much has been written about the importance of this or that kind of plowing. Actually, however, there appears to be no one best way, and excellent corn crops have been produced following fall plowing, spring plowing, deeper plowing and shallower plowing, plowing preceded by disking, plowing just before planting without previous cultivation, etc. Except that land should not be plowed when it is too wet, should not be plowed and left when excessive soil washing or blowing will result, and should be plowed thoroughly and to a reasonable depth, there appear to be few absolute "dos" or "don'ts".

Land is too wet to plow when the operation breaks down the soil structure into finer particles and puddles it (fig. 3). The effect is least damaging to sandy soils and is increasingly injurious on heavier soils. Even on sandy loams, however, wet plowing may make it impossible to put the soil in good condition for planting because of cloddiness. On clays the unfavorable effect of a single plowing when too wet may last for years. Land can be plowed somewhat wetter in the fall than in the spring. This is particularly true of sod land in the North. The roots tend to protect it from puddling, and the thorough freezing to which it is subjected tends to offset any slight puddling effect.

EROSION AND SOIL BLOWING

Plowing results in a better absorption of rainfall by loosening the soil and providing a rough surface from which the run-off is slower. Until the soil has become nearly saturated, therefore, plowing tends to reduce erosion or soil washing. After saturation is reached, however, the soft plowed soil without protecting surface vegetation is particularly subject to washing, with its attendant loss of fertility. In areas where rainfall may be expected to be heavier than the soil can absorb, there accordingly is every reason not to plow land unnecessarily long before it is to be prepared and planted. Loss by erosion is likely to be less on more level lands, less from lighter, more porous soils, and less in areas where rainfall is well distributed and not excessive. Erosion may be reduced on rolling land by terracing (fig. 4). Damage by erosion during the winter is less in the north, where the soil freezes fairly early and where much of the winter precipitation is in snow. Erosion is most serious in the South, where the winters are open and the winter rainfall relatively heavy.

Although losses from soil blowing usually are not so evident as those from erosion, they may be equally serious. The low rainfall, the light soils, and the high winds common to the Great Plains make it necessary to guard against soil blowing throughout this area. To the east, in the Corn Belt, damage from blowing tends to decrease but continues to be of importance wherever lighter soils occur. The best protection against soil blowing is to expose the bare soil surface to wind action as short a time as may be. Fall plowing of light soils therefore should be avoided except when the general system of management makes this necessary. Blowing can be reduced mate-

FIGURE 3.—Land in good condition for plowing.

rially by leaving the surface as rough as possible or even definitely ridged. Thus, in the Great Plains the land may be blank listed in the fall and the ridges then broken out in the spring at planting. The use of large plows and plowing a little wet also will tend to leave the soil in a condition less subject to blowing. In general, however, the proportion of corn on soils light enough to blow badly should be small enough to make it unnecessary to fall plow.

TIME OF PLOWING

The time of plowing in preparation for corn will be determined largely by the locality, the system of farming, and the previous crop. Land that has been in a cultivated crop—corn, cotton, soybeans, potatoes, etc.—can be plowed about equally well in the fall or spring, so far as the yield of the following corn crop is concerned. The same is true of land in the Great Plains area that has been in small grain. The differences in yield of corn following spring plowing and fall plowing in the many experiments tried under such conditions tend to favor the spring plowing, but are too small to be important.

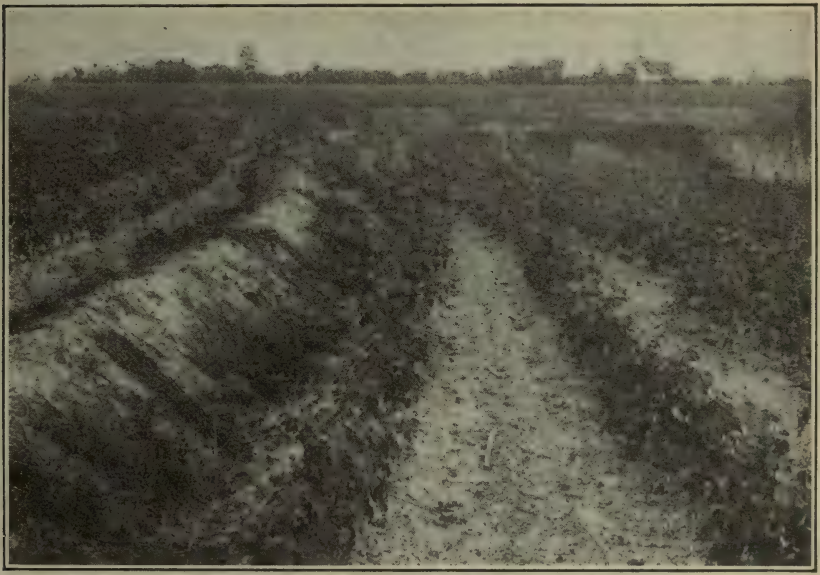

FIGURE 4.—A cultivated field in which soil washing is largely prevented by terracing.

Fall plowing in the Southern States is undesirable because it promotes soil washing and because vegetation turned under in the fall may decay so rapidly as to be of little value to the following corn crop. Fall plowing also should be avoided on soils subject to blowing.

In the Corn Belt, where a large part of the cultivated acreage is in corn, it usually is necessary that at least part of this be fall plowed if the crop is to go in on time in the spring. In general, the fields to be fall plowed should be those that have been in alfalfa, clover, or pasture. Fall plowing these will permit the sod to break down and settle partly during the winter and make for easier and quicker final preparation of the seed bed in the spring. The freezing of the turned soil during the winter also will help to reduce the number of insects that sometimes cause serious damage to stands of corn on sod land.

DEPTH OF PLOWING

Plowing on all soils should be deep enough to turn all surface growth under where it will remain moist and decay. This will leave a surface layer of soil free from trash to be worked down into a fine seed bed. Plowing has the added important function of loosening the soil so as to promote both aeration and better absorption of rainfall. On lighter soils this needs little consideration. Plowing deep enough to leave a clean surface will take care of it automatically. On heavier soils somewhat deeper plowing may be desirable.

Plowing less than 5 or 6 inches deep usually is insufficient to turn under surface growth and trash properly so that it will be out of the way. Plowing more than 7 or 8 inches deep, or subsoiling, usually is wasted energy. Between these limits, plowing should be somewhat deeper on heavier soils, when heavy vegetation or sod is turned under, and when done in the fall. Conversely, it may well be at the lower limits in spring plowing of lighter soils that have been in cultivated crops.

The depth of plowing generally should not be increased suddenly much beyond what it has been during previous years. Bringing more than about an inch of cold "lifeless" subsoil to the surface at once nearly always results in a poor crop, particularly on heavier soils. On some bottom-land soils and in semiarid areas this condition does not occur. Usually, however, where land has been plowed too shallow for several years it is much safer to increase the depth of plowing gradually at the rate of about an inch at a time.

FINAL PREPARATION

The final steps in preparing land for corn consist in obtaining a surface layer of some 2 inches of reasonably fine soil in which to plant, and, of even more importance, putting the entire 5 to 8 inches of soil that has been turned by plowing in the best condition to promote full development of the plants throughout their growth. This requires that the turned soil be worked down into a well-pulverized, fairly compact mass free from large air spaces either within itself or between it and the unplowed subsoil. In general, too much attention is given to having a very fine surface inch or two, and too little attention to proper preparation of the lower part of the seed bed.

The final preparation should precede planting as shortly as possible to avoid both excessive drying and the chance of rain ruining the seed bed that has been prepared. On small farms the field can be prepared and then planted immediately. On larger farms facilities usually allow the planter to follow immediately behind the last harrowing or dragging.

Land that was plowed and left in the fall frequently can be put in excellent condition simply by double disking and harrowing. Spring-plowed land sometimes can be fitted satisfactorily by similar treatment. On heavier soils, however, the use of a corrugated roller will help to a firmer and better seed bed. The ease of fitting spring-plowed land can be increased tremendously by harrowing immediately after plowing and then waiting to finish preparation until just before planting. Harrowing the day of plowing tends to crumble the soil slightly and to prevent the furrow slice from drying out too fast and baking.

Finishing the preparation with a plank drag leaves the soil surface smooth and even for planting. It helps materially in planting to have the harrowing or dragging at an angle to the planting direction by making the marker furrow stand out more plainly.

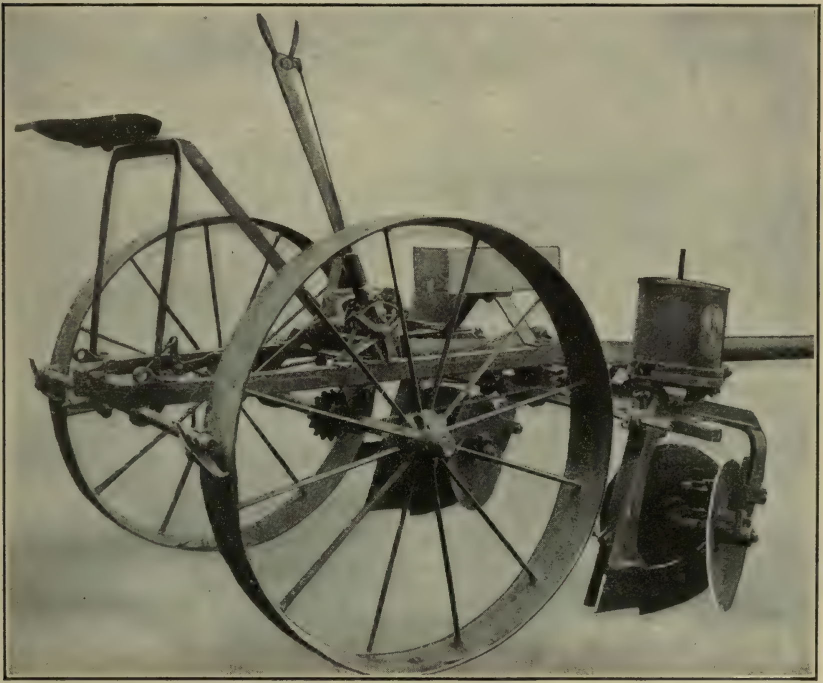

FIGURE 5.—A 2-row corn planter with disk openers for furrow planting. These can be used in drilling or checkrowing.

PLANTING CORN

Most of the corn in the Corn Belt is planted in hills in checkrows. This permits cross cultivation and the control of weeds without hand hoeing. In some areas disk furrow openers are attached to the planter so as to plant in shallow furrows and still have the corn checked in hills (fig. 5). Toward the western part of the Corn Belt and in the Great Plains listing without previous plowing is a common practice. The land is laid off in alternate ridges and furrows, the corn being planted in the bottom of the furrows either at the time of laying off (with a lister planter) or later. Listed corn usually is drilled and can be cultivated only in one direction, but the weeds in the rows can be controlled easily while the furrows are being filled during cultivation.

In some parts of the South corn is planted much as in the Corn Belt. On many of the more poorly drained soils, however, it is customary to plow the land into beds the width of a corn row and to plant in these beds. The word "listing" sometimes is applied locally in the South to this method of planting corn in the bed or "list." Throughout the South, however, some farmers here and there plant their corn in water furrows. This is essentially the same as the listing followed farther north, except that the land usually is first bedded and the corn then planted in the furrows between the beds. In the South this practice is largely, though not universally, restricted to late-planted corn.

Planting corn in hills in level, well-prepared soil is probably the best method for most of the Corn Belt. This permits the efficient use of large plows, planters, and cultivators. Planting in drills rather than hills makes for somewhat larger corn yields, owing to the better distribution of the individually spaced plants in the drill row. The results of many experiments, however, show that this difference is unimportant even when weeds are controlled in the drilled corn. Moreover, it is practically impossible to control weeds in level-planted drilled corn in most corn soils without hoeing. Without hand hoeing to maintain equal freedom from weeds, checked corn usually will yield more than that which is drilled.

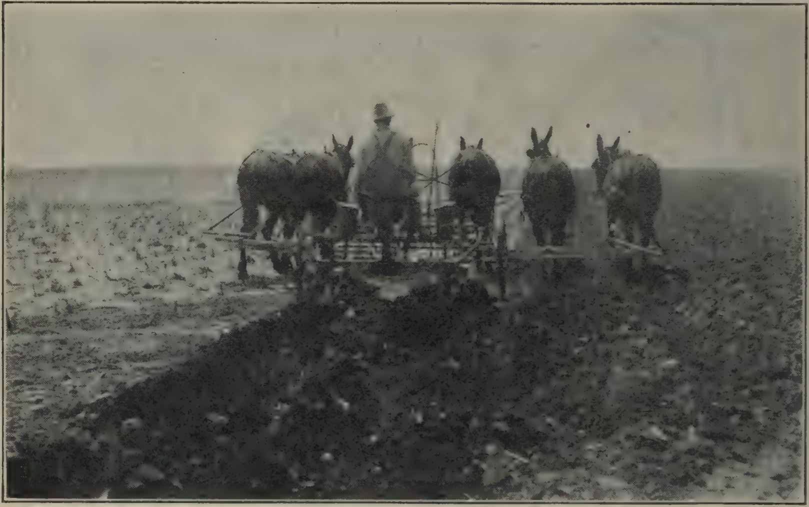

FIGURE 6.—A lister planter in the Great Plains area.

Listing corn usually results in the lowest acre cost of production. In its simplest form the land is not plowed or otherwise cultivated previous to planting. The corn is planted directly in the furrows thrown out by the lister planter, the whole operation being carried out at one time (fig. 6). In other systems the land may be broken or blank listed ahead of the actual planting. Blank listing followed by cultivation of the furrows and finally by planting tends to give the young corn plants a somewhat better start by providing a warmer seed bed. It also tends to control weeds somewhat better by killing those that have started between the time of listing and the time of planting.

In addition to the advantage of easier weed control, listing corn achieves two very definite objectives. It tends to retard the early development, thereby making the plant less susceptible to injury from drought later on. Listing also puts the main root system of the corn plant several inches deeper than it would be with level planting, and the somewhat thicker layer of soil above this main root system then can be cultivated with less injury to the roots (fig. 7).

The slower development of the young plants in listed corn makes the method unsatisfactory for those areas in which the frost-free period is relatively short and every day of the growing season must be utilized if satisfactory yields are to be obtained. In such areas, blank listing followed by cultivation of the furrow bottoms to warm the seed bed and give the corn a better start could be utilized to eliminate in part this undesirable checking of early development. This, however, does away with those advantages of listed corn which come from the low cost of the method and the slow early development. Listing corn probably is most advantageous on lighter soils in districts where a shortage of moisture is likely to occur during the later part of the season. Thus, in the drier sections of the Great Plains area, or elsewhere on soils of somewhat similar type, listed corn may be expected to yield more than level-planted corn.

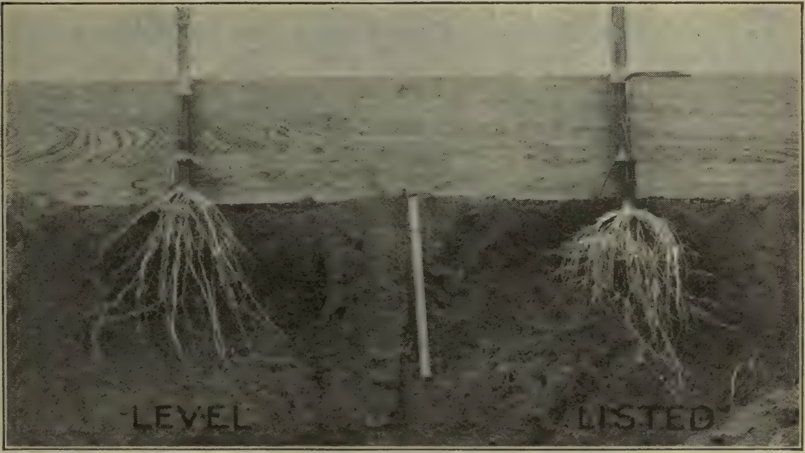

FIGURE 7.—The depth of rooting in level-planted (left) and in listed (right) corn.

Throughout much of the Cotton Belt a deficiency in rainfall during July and August, just when the corn plants are making their heaviest demands, frequently is the major factor limiting corn production. Where the soil is not too cold and heavy, and there is reasonable drainage, listing may be advantageous. On the lighter alluvial soils of this region listing offers particular possibilities.

Planting with furrow openers combines some of the advantages of listing and level planting. It may be practiced on soils that are too heavy or too poorly drained to make listing satisfactory. At the same time the roots are placed slightly deeper in the soil, and the small weeds in the rows can be controlled somewhat better than with level-planted corn. Corn is planted with furrow openers, however, only on prepared land, so that the cost is as great as for ordinary level planting. Moreover, it cannot be harrowed or gone over with the rotary hoe or weeder as satisfactorily as that which is level planted. Except where a real advantage in yield has been shown for this method, therefore, it is questionable whether it can be recommended.

Corn planted in elevated beds wide enough for a single row rarely produces satisfactory yields. It should be used only on poorly drained land where it is necessary to have frequent water furrows if the seed is to germinate. Even in such areas, however, lack of water during some period of the growing season usually is the factor limiting yield. Corn grown on these narrow beds can be cultivated only with severe damage to the roots. It is in an ideal position, therefore, to suffer most from lack of moisture later on. Where it is necessary to "bed up" in order to obtain stands of corn, the beds may be made wide enough to accommodate two or more rows with the water furrows between beds (fig. 8). The corn then can be planted in shallow furrows on top of the beds. The deeper rooting obtained in this way will permit the beds to be worked down during cultivation without damage, leaving the land nearly level at the last cultivation.

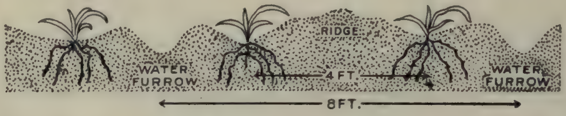

FIGURE 8.—Diagram showing a method for planting corn on low wet ground.

TIME OF PLANTING

Corn planting begins in southern Texas, usually before February 1, and progresses northward through the eastern two thirds of the United States at an average rate of about 13 miles a day (fig. 9). Planting is relatively somewhat earlier in the central part of this area, being delayed toward the west by higher elevations and toward the east by heavier, colder, and wetter soils. In the western third of the United States the date when planting begins is determined so largely by elevation that the dates for given locations can be indicated only.

Planting becomes general in from 1 to 2 weeks after the beginning dates indicated in figure 9, and is almost completed by from 3 to 4 weeks after these dates. The spread between the beginning and ending of planting is least in the extreme north and becomes wider toward the south. In much of the Cotton Belt there are two more or less distinct corn-planting periods. The first, for which dates are shown in figure 9, begins before and continues partly with cotton planting. The second and less important period begins about June, after the cotton has been planted and chopped.

The best time to plant corn usually will be as soon after the beginning date indicated above as the soil is in good condition for plant-

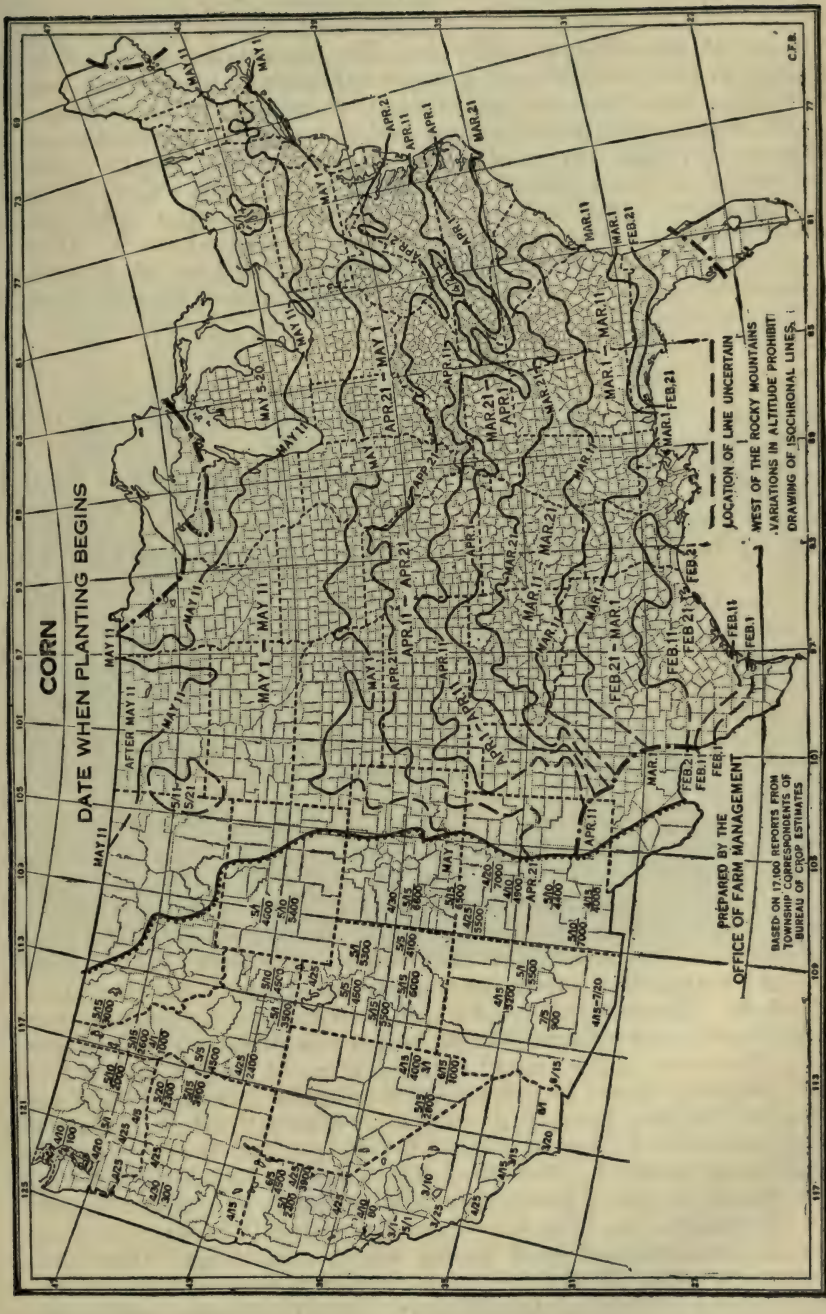
CORN
DATE WHEN PLANTING BEGINS
LOCATION OF LINE UNCERTAIN
WEST OF THE ROCKY MOUNTAINS
VARIATIONS IN ALTITUDE PROHIBIT
DRAWING OF ISOCHRONAL LINES
PREPARED BY THE
OFFICE OF FARM MANAGEMENT
BASED ON 17,100 REPORTS FROM
TOWNSHIP CORRESPONDENTS OF
BUREAU OF CROP ESTIMATES
C.F.B.
AFTER MAY 11
MAY 11
MAY 5-20
MAY 1 — MAY 11
APR.21 — MAY 1
APR.11 — APR.21
APR.1 — APR.11
MAR.21 — APR.1
MAR.11 — MAR.21
MAR.1 — MAR.11
FEB.21 — MAR.1
FEB.11
FEB.1

FIGURE 9.—Map showing dates on which corn planting begins.

ing and the weather is fit. The dates indicated are averages, and in late springs temperatures lower than normal make it advisable to delay planting. Similarly, it is futile to plant corn early in a cold, poorly prepared seed bed. The seeds will not germinate well under such conditions, and many will rot. The result is a poor stand, with no gain in advancement over a somewhat later planting when conditions for germination and growth have become more favorable.

Corn can be planted somewhat earlier on lighter or sandier soils than on the colder clays, and earlier on more productive than on less productive soils. Application of commercial fertilizer in the hill at planting will promote early growth and partly offset unfavorable conditions that often prevail when corn is planted early. Where planting has been delayed unduly because of cold or wet a similar application may increase the rapidity of development enough to make up for the loss.

RATE OF PLANTING

The rate of planting corn should be adjusted to the size of the plants and the productivity of the soil. The rank-growing, long-season varieties adapted to the Southern States will not stand nearly so thick planting as do the smaller varieties of the North. In the Great Plains area the frequent lack of moisture when corn needs it the most requires thinner planting in spite of the productive soil. Soils capable of producing 80 bushels per acre will make their best yields, with perhaps a 50 percent thicker stand than will adjacent fields capable of producing only 40 bushels.

As a result of 5 years' experiments the Illinois Agricultural Experiment Station recommended planting 3 kernels per hill in hills 3 feet apart each way for Corn Belt soil in northern Illinois. For central Illinois the station recommended 3 kernels per hill in hills 3.3 feet apart for soils capable of producing acre yields of more than 50 bushels, and 2 kernels per hill in hills 3 feet apart for less productive soil.

In Iowa larger average yields for a 5-year period were obtained in the northern half of the State from planting 5 kernels per hill than from planting 4, 3, or 2 kernels. In the south-central fourth of the State the largest yield was obtained from planting 4 kernels per hill, and in the southern fourth of the State from planting 3 kernels. Varieties adapted to each section were used, and the average yield for the best rate in the four sections ranged only from 61 to 67 bushels. The superiority of the thinner rate in the southern part of the State was a reflection of the larger size of the varieties grown there. The data on final stand from planting at these different rates show that only about 75 percent of the kernels planted at the rate of 4 and 5 kernels per hill as compared with 80 and 84 percent of those planted at the rate of 3 and 2 kernels per hill were represented by plants at harvest. The actual final stands accordingly were 1.7, 2.4, 3.0, and 3.7 plants per hill from planting 2, 3, 4, and 5 kernels.

In Minnesota, planting 3 or 4 kernels per hill in 44-inch checkrows produced about equal yields, which were larger than those obtained by planting either 2 or 5. The 3-kernel rate produced a larger proportion of marketable corn. In Ohio larger yields were obtained over a 10-year period from planting 4 kernels in hills 3.5 feet apart each way than from planting either fewer or more. The

4-kernel rate produced smaller ears and more nubbins than the 3-kernel rate, and the stover was finer. Comparisons in Arkansas extending over 4 years showed larger yields from stands equivalent to about 2½ and 3 plants per hill in rows 44 inches apart for corn grown under favorable conditions and from somewhat thinner stands under less favorable conditions. In eastern Kansas experiments with drilled corn on creek-bottom land favored spacing the plants 16 inches apart in the row, as compared with 12, 20, 24, 28, and 32 inch spacing. On upland, the largest yields were from 20 and 24 inch spacings. In both experiments, however, there was little difference between the corn spaced 16, 20, and 24 inches apart, although the stand at the 16-inch spacing was 50 percent thicker than that at the 24-inch spacing.

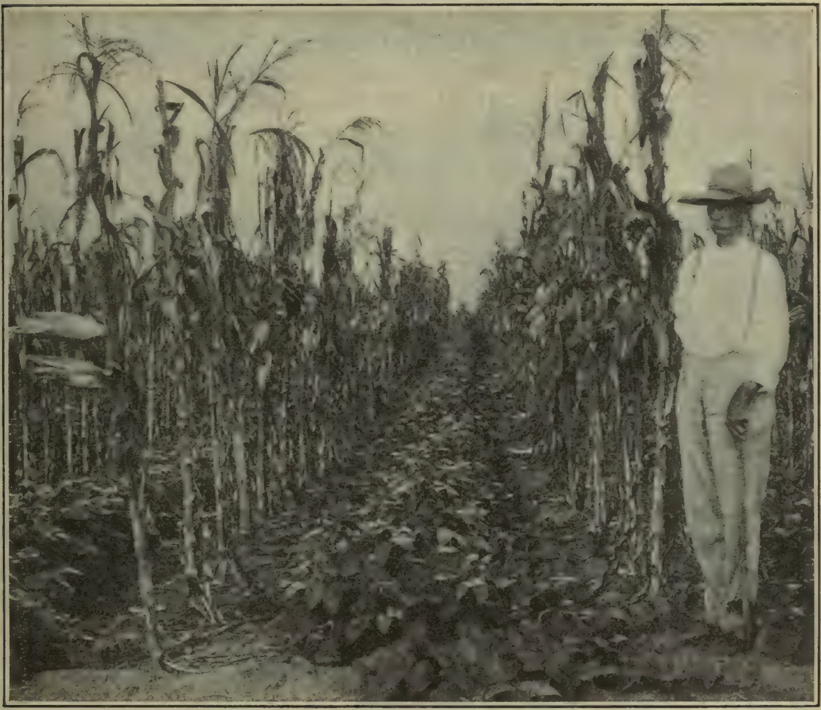

FIGURE 10.—Widely spaced corn rows with cowpeas in the middles.

In contrast to these relatively thick rates, the Georgia Agricultural Experiment Station concluded that on upland soil capable of producing acre yields of from 35 to 40 bushels, rows 4 feet apart with plants spaced 2 to 2½ feet in the row would produce the largest yields, and that on thinner soils the spacing should be greater (fig. 10).

In most of the experiments on rate of planting, the yields from 2 or even 3 rates have been so close together that the differences were unimportant. In such cases the decision as to the rate to use should depend upon other considerations. In general, the thinner of two rates yielding approximately equally over a period of years may be expected to yield more than the thicker in the less favorable seasons, and particularly so under extreme conditions. Corn planted at the thinner rate also will produce larger ears, have fewer barren plants, and tend to lodge less than that planted more thickly, with a consequent lower cost for husking.

DEPTH OF PLANTING

Corn should be planted deep enough to put the seed in moist soil where it will not be in danger of drying out. In soils that tend to be cold, an inch or an inch and a half is deep enough. On sandy soils, where the surface is drier, it may be necessary to plant 3 inches deep or, rarely, even more. It is particularly important not to plant corn any deeper than need be early in the season. At that time the soil is less likely to dry out around the seed, making deep planting unnecessary, and the higher temperatures near the surface will favor more rapid germination and vigorous growth.

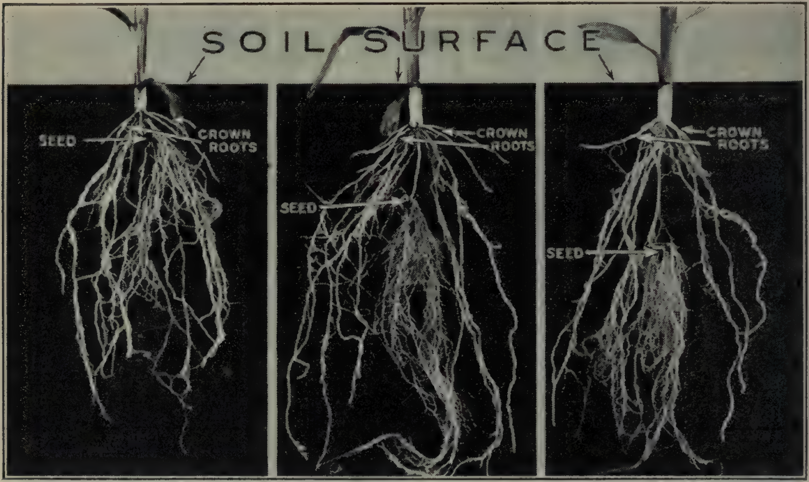

FIGURE 11.—Depth of planting corn has little effect on the depth of the crown roots.

It sometimes has been thought that deeper planting would result in deeper rooting. It is the crown roots, however, on which the corn plant depends during its later growth. These develop just a little below the surface of the soil, regardless, within practical limits, of the depth of planting, as shown in figure 11.

CULTIVATION

The object of cultivation frequently has been stated as being (1) to control weeds, (2) to increase absorption by reducing run-off, (3) to check evaporation by maintaining a mulch, and (4) to increase aeration of the soil. Undoubtedly cultivation performs all of these functions under certain conditions, but it seems equally certain that the one all-important reason for cultivating corn usually is to control weeds.

The importance of maintaining a dust mulch formerly was stressed as a means of preventing evaporation from the soil surface. The soil in a cornfield, however, is so filled with corn roots that almost no moisture can come up past them to reach the surface unless there is an excess present. Cultivating this root-filled soil does practically nothing to save needed moisture and at the same time injures the roots of the corn plants to a greater or less extent, depending on how it is done and on other conditions (fig. 12). The roots of weeds come into direct competition with those of the corn plants for both moisture and nutrients. It therefore is essential that weeds be controlled.

Hundreds of experiments have been conducted by the State agricultural experiment stations and by the United States Department of Agriculture in which have been compared the yields of corn from cultivated plots and from plots from which the weeds have been scraped with a hoe without disturbing the soil any more than necessary. In most of these comparisons the difference in yield has been negligible, sometimes one method being slightly better and sometimes the other, clearly indicating no particular difference. In a few experiments distinctly better results were obtained by cultivating and in a few by scraping.

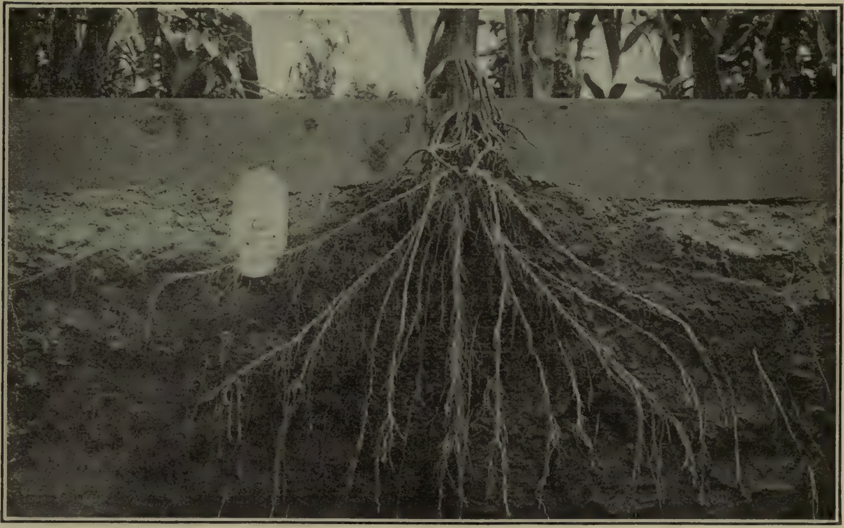

FIGURE 12.—Corn roots as they grow. The bottom of the board rests on the soil surface, and the cultivator shovel shows how deep cultivation injures the roots.

There also have been extensive experiments on the merits of deep and shallow cultivation. In some of these shallow cultivating has been superior to deep cultivating, but in none has there been any important difference in favor of deep cultivation. Other experiments have failed to show any benefit from unusually frequent cultivation or from unusually late cultivation. The results of all the experiments considered as a whole indicate that cultivating as often and as deep as is necessary to control weeds, and no more, is the desirable practice.

IMPORTANCE OF EARLY CULTIVATION

Weeds can be killed most easily and cheaply when the field is being prepared for planting and before the corn is up or while it is small enough to stand harrowing without injury. At such times the land can be gone over quickly with the harrow, weeder, or rotary hoe. These implements are highly efficient in controlling weeds if used before the latter become established, and they hold down the cost of cultivation.

Harrowing from just before to just after the corn seedlings emerge should be avoided unless it is essential. At this stage the young plants are very brittle and those broken below the surface have difficulty in emerging. The soil sometimes may crust after beating rains to such an extent that the value of breaking the crust may offset possible damage to the seedlings. Such occasions, however, are rare. After the plants are well up they may be harrowed with little damage until they are some 4 inches high. Less injury will be done by harrowing in the late mornings and afternoons than in the early mornings when the plants are more tender.

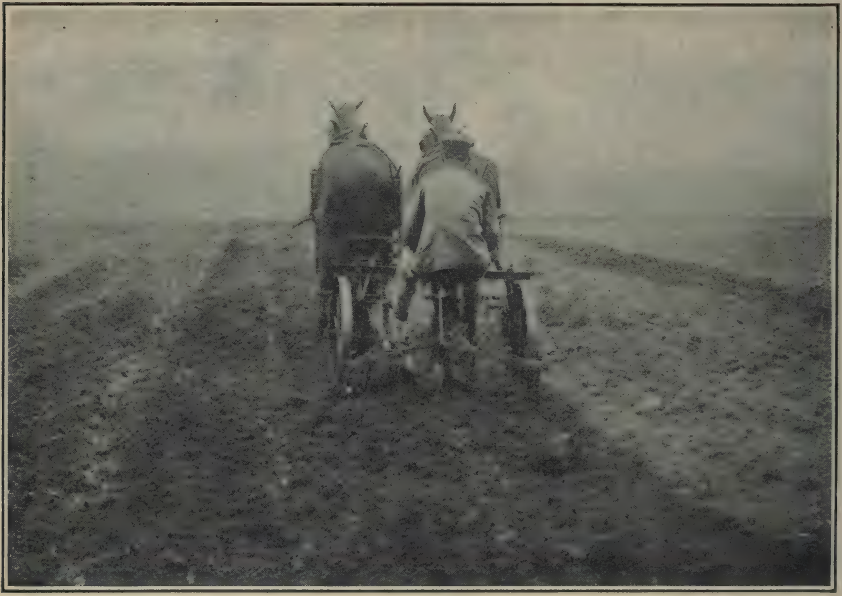

FIGURE 13.—A corn cultivator equipped with narrow shovels and fenders for early cultivation.

LATER CULTIVATIONS

Later cultivations can be made satisfactorily with any of the usual cultivators. While the plants are very small, narrow shovels that throw the soil but little should be used, and fenders usually are desirable to prevent covering or injuring the corn (fig. 13). The same equipment without the fenders can be used for subsequent cultivations, or wider shovels (fig. 14) or surface cultivators (fig. 15) can be used, depending upon local conditions.

Corn should be cultivated often enough to control weeds. More cultivation accordingly will be required in seasons of frequent rainfall. With weeds controlled, additional cultivation is a waste.

In general, cultivation should be no deeper than needed to control weeds. Shallow cultivation is less likely to injure the corn roots (fig. 12) and does not bring many weed seeds to the surface.

Corn can be cultivated most efficiently as soon after rains as the soil is dry enough to work well. At this time the newly germinating weeds are killed most easily and the soil is left in the best physical condition. Corn should not be cultivated when the soil is so wet that puddling may result.

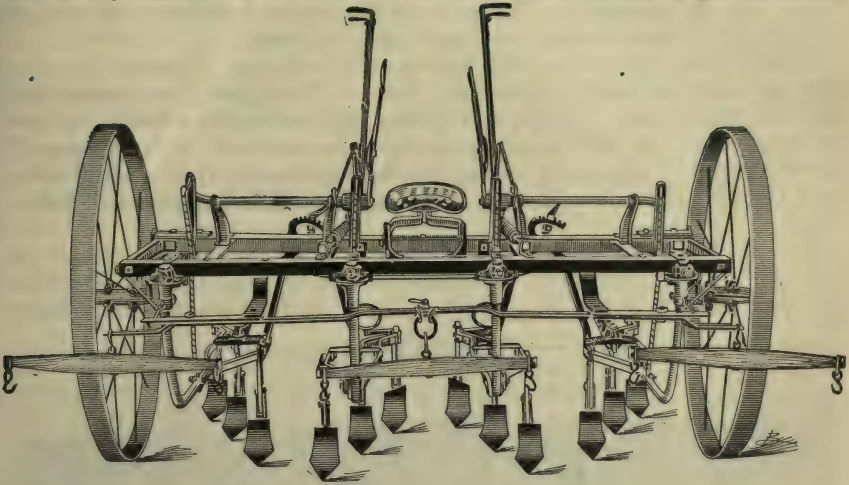

FIGURE 14.—One kind of 2-row cultivator.

CULTIVATING LISTED CORN

One of the objects of listing corn is to obtain deeper rooting of the plants (fig. 7). This can be accomplished only if the furrows are kept open until the crown roots are established (fig. 11). A 2-row lister-cultivator used in the first cultivation of listed corn is shown in figure 16. The disks in this case are set to cultivate the sides of the furrows without pulling the soil down into them. The second cultivation may be given with the same implement set to fill the furrows partly, or with any of the ordinary cultivators. Ordinary cultivators are used for the third and any necessary subsequent cultivations, the furrows being filled during the third cultivation.

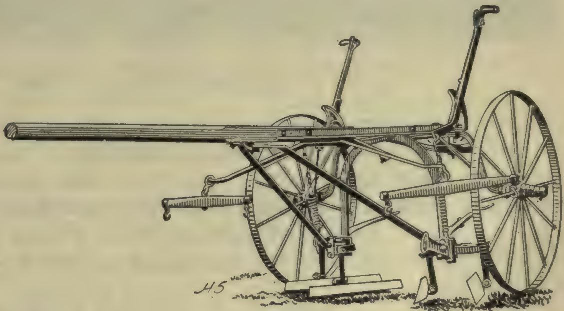

FIGURE 15.—A double cultivator equipped for surface cultivation.

ECONOMY IN CULTIVATING

Mention already has been made of the desirability of utilizing large tools in the early cultivations. This permits covering the whole field more quickly and reduces the labor cost. Thus, under conditions similar to those in central Illinois, one man with 4 horses can harrow from 25 to 30 acres in a 10-hour day, whereas he can cover only about 15 acres with a 2-row riding cultivator in the same time. With 2 horses and a 1-row riding cultivator only 7 to 8 acres can be covered in 10 hours, or about one half of what can be done with a 2-row riding cultivator and 4 horses.

Large tools cannot be used under all conditions. Insofar as they can be used efficiently, however, they will do much to reduce the cost of production. In the first place, they eliminate labor otherwise necessary for the particular operation. In addition, they frequently permit completing the operation while it is most timely and effective and thereby eliminate the need for additional labor at some future time.

The largest item in the cost of corn growing is labor, and it is in this item that reduction in production costs must be made. No formula can be given as to just when a farmer should plow, disk, harrow, or cultivate in order to keep down the cost. The soundness of judgment of the individual farmer in determining the proper time for these operations, however, will do much to eliminate unnecessary expense. Finally, it is not enough to know what to do and when to do it. In addition he must be a good manager so that other activities will not prevent his doing the necessary work at the right time.

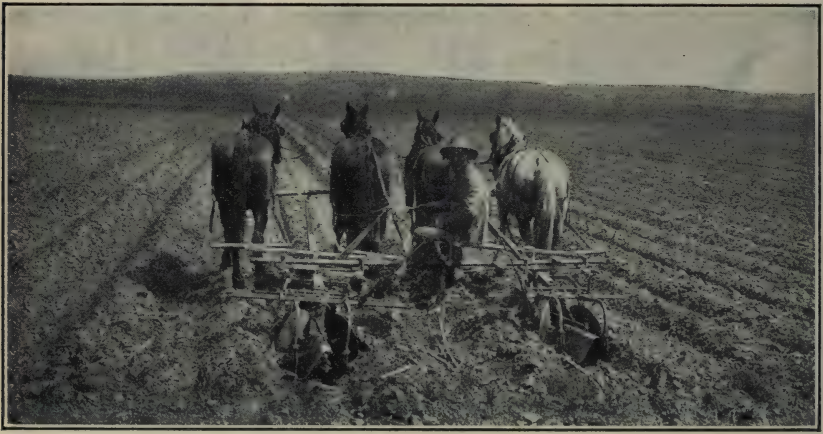

FIGURE 16.—The first cultivation of listed corn. The row at the driver's feet will be cultivated on the return trip.

INSECTS INJURIOUS TO CORN[4]

Corn is the favored food of many insect pests. More than 350 different species are known to attack corn, and of this number over 160 are particularly injurious. This most destructive group includes such well-known pests as the corn ear worm, European corn borer, grasshoppers, cutworms, rootworms, army worms, sugarcane borer, grain weevils, various kinds of aphids, white grubs, and many other kinds of beetles, bugs, and borers. The insects that may be considered of special interest in corn production are discussed briefly in the following paragraphs.

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[4] Prepared by W. H. Larrimer, principal entomologist in charge, Division of Cereal and Forage Insects, Bureau of Entomology, U.S. Department of Agriculture.

The corn ear worm is familiar to every corn grower, and the damage it does is of such general and common occurrence that it is accepted as more or less necessary. The injury is caused entirely by the worms, or larvae of the insect; and while considerable damage is done to the unfolding leaves, the tassel, and the fresh silks of corn, the principal injury is to the tips of the ears. Damage by the corn ear worm may be kept at a minimum by growing a variety of corn that is suited to local conditions and has a long, tight husk. The general level of infestation may be reduced by plowing after the corn is cut to kill the overwintering form of the insect in the soil.

The European corn borer entered the United States about 1909 or 1910 in shipments of broomcorn from southern Europe. It was discovered in the summer of 1917 near Boston, Mass., and soon afterwards near Schenectady and Buffalo, N.Y., and near St. Thomas, Ontario. It has since spread from these original infestations until, at the close of 1932, it was known to occur throughout most of the New England States, New York, Pennsylvania, New Jersey, the Eastern Shore of Maryland and Virginia, Ohio, Michigan, and the northeastern half of Indiana, with isolated infestations in northern West Virginia and northern Kentucky. The chief methods of control consist in the utilization or destruction of all parts of the corn plant before May 15 by any one or a combination of the following methods: Feeding, burning, or plowing under cleanly.

Grasshoppers should never be allowed to get into the cornfield. Moderately careful observation will detect a threatening infestation of grasshoppers before the young hoppers leave their hatching grounds, principally along fence rows and headlands. Poisoned-bran bait applied to these areas while the young hoppers are still on their hatching grounds or, at the very latest, as soon as they begin to migrate, has been proved to be a very effective and economical control for these destructive insects.

Cutworms are the caterpillar stages of night-flying moths. These moths lay their eggs on plants or other objects, or directly on the ground, and the eggs hatch the cutworms. Many kinds of cutworms go through the winter in the soil and begin work early in the spring, such work being done ordinarily at night or on dark, cloudy days. Control can usually be obtained by the application of poisoned-bran bait, very much the same as for grasshoppers.

The southern corn rootworm in the larval stage feeds on the roots of corn or, in the case of young plants, drills a small hole into the stem just above the first circle of roots, killing the bud. Such plants either die outright or are so badly stunted as to be unproductive. Clean culture and crop rotation will largely prevent injury from this pest if the system of farming is such as to permit these practices.

Because of the great number of insect pests attacking corn and the diversity of habit of these various pests, no general recommendation can be depended upon to be universally effective as a control. In general, communities in which the farms are well managed, with clean, well-cultivated, fertile fields, clean fence rows, and crops intelligently rotated and grown from seed of adapted varieties have the least trouble with insect problems. In the event that specific information is desired on any particular insect, specimens of the insect causing the damage, together with a sample of the injured plant, should be sent either to the State agricultural experiment station or to the Bureau of Entomology, United States Department of Agriculture, Washington, D.C.

DISEASES OF CORN

Corn, in common with most crop plants, is subject to many diseases. Some of these are largely local in their distribution or importance, whereas others are more widespread. The discussion here is limited to the two most important diseases and treats them only briefly. Bulletins containing more complete information about these and other corn diseases may be had from the United States Department of Agriculture and the various State agricultural experiment stations.

Corn smut probably is the most common disease of corn in the United States. The galls incident to this disease develop on any of the aboveground parts of the plant and may become several inches in diameter. In the earlier stages they are white or gray, later becoming black. When mature they rupture, releasing the dense powdery mass of black spores inside.

Infections with corn smut do not come from the seed, and there is no way of controlling the disease. Adapted varieties in general tend to be more resistant than unadapted sorts, but no highly resistant varieties so far are available. Inbred strains that are highly resistant to smut and that offer much promise as a basis for producing highly resistant varieties or hybrids within a few years have been isolated in the corn-breeding programs of the United States Department of Agriculture and some of the State agricultural experiment stations.

The rot diseases of the roots, stalks, and ears of corn are caused by a number of different fungi and are widely distributed but are of far more importance in some sections than others as regards both occurrence and damage.

The symptoms differ, depending upon the particular fungi involved. In general, as the name suggests, they comprise a rotting of one or more parts of the corn plant and cause loss either directly, as of ears rendered unfit for use, or indirectly by interfering with plant development and consequent yield and quality.

The organisms responsible for this group of diseases may live over in the field or be carried on the seed. Field infection may be reduced by suitable crop rotation. Careful selection and testing of seed from plants not showing symptoms of rots will aid in avoiding infection from this source. Maintaining an adequately balanced condition of soil fertility helps in the control of the rot diseases. Seed treatment with the newer mercury-compound dusts also is warranted in areas where these diseases are an important factor. In some localities, however, seed treatment has not increased the yield, and under such conditions it is an unnecessary expense. The ultimate control of these diseases lies in the breeding of resistant sorts, which is under way in the States where the diseases are important.

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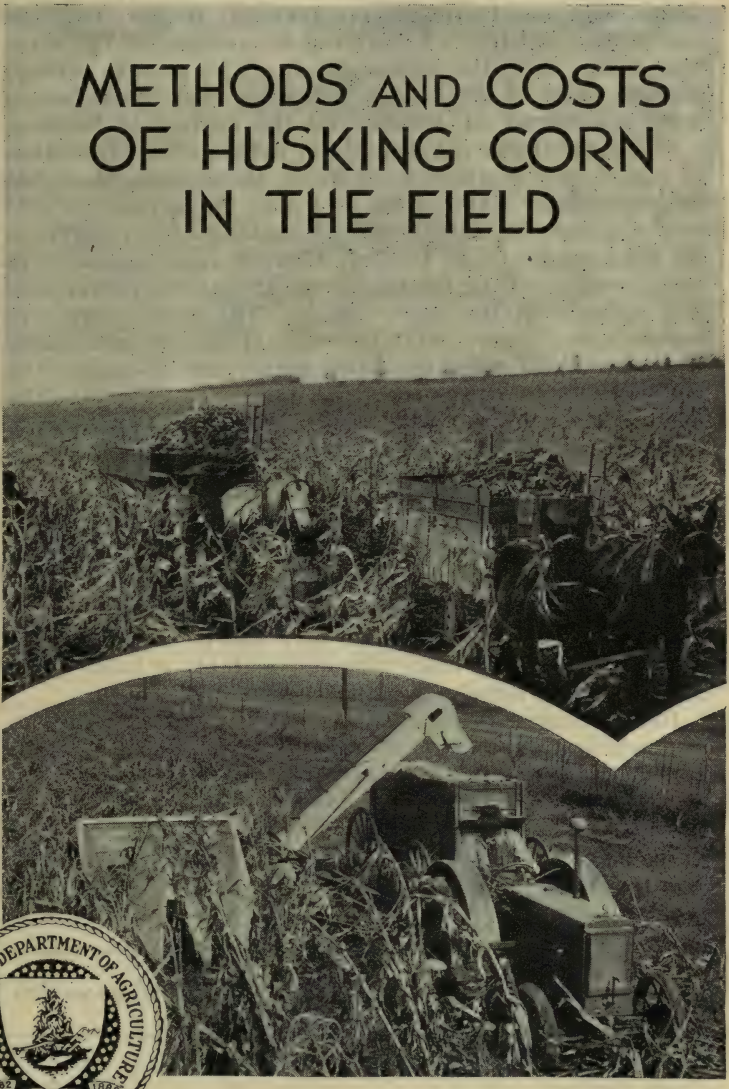
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1715

METHODS AND COSTS OF HUSKING CORN IN THE FIELD



MECHANICAL CORN PICKERS are used chiefly on farms that have relatively large acreages of corn. An average of 96 acres of corn was husked on the home farms with the 1-row pickers included in the study on which this bulletin is based, and an average of 137 acres was husked with the 2-row pickers. The average acreage husked varied a great deal, indicating that other factors were considered in deciding on the method of husking.

The use of the mechanical picker involves the substitution of power and equipment for much of the man labor that is used when husking corn by hand. An average of 5.23 hours of man labor was used in husking an acre of corn by hand on the farms studied, whereas an average of 2.72 hours was used in husking with the 1-row picker and 2.21 hours with the 2-row picker. The horse work was reduced even more, but 1.20 hours of tractor and picker use were added when the 1-row picker was used and 0.80 hour when the 2-row picker was used. To determine the most economical method, therefore, depreciation, interest, and repairs on the tractor and picker must be balanced against the reduction in value of man labor and horse work used in hand husking.

Advantages of the mechanical pickers over hand huskers, aside from the cost considerations, may be summarized as follows: (1) The mechanical picker reduces the labor problem involved in hand husking, (2) husking may be started earlier and completed in a shorter time, (3) the work is easier and more pleasant, and (4) a larger corn acreage can be handled with the available labor.

Disadvantages of mechanical pickers are: (1) The investment in equipment is materially increased; (2) weather conditions, particularly late in the husking season, may make husking unsatisfactory and sometimes impossible; (3) More corn may be left in the field unless great care is taken in operating and adjusting the machine; and (4) the value of the stalk fields for pasture is reduced.

Washington, D.C. **Issued September 1933**

METHODS AND COSTS OF HUSKING CORN IN THE FIELD

By KENNETH H. MYERS, *associate agricultural economist, Division of Farm Management and Costs, Bureau of Agricultural Economics*[1]

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DEVELOPMENT OF CORN-HUSKING MACHINERY

CORN OCCUPIES a greater acreage of land than any other crop, and approximately 80 percent is harvested from the standing stalks, but the development of corn-husking machinery has not kept pace with the development of some other lines of farm equipment. A machine for husking corn in the field was patented in 1850, and during the next 30 years many devices for removing the ears from the stalks were tried. The snapping roller was invented in 1874 and gave promise of being more successful than the earlier devices used to break the ears from the stalks. It received considerable attention for a time, but the development in 1892 of a corn binder embodying principles which have since prevailed, and in 1895 of the self-binding harvester drew attention from the corn husker.

Following 1902 several machines for husking corn appeared on the market, all of the same general type and similar to those sold today except for the source of power. These early machines were drawn by horses, and the husking mechanism was driven from a bull wheel or by a motor mounted on the frame. These machines were effective under favorable conditions, but when the ground was soft husking was unsatisfactory and often impossible.

Considerable expansion in the use of mechanical huskers or, more simply, " pickers ", took place soon after the World War. The scarcity and high cost of labor and the increased use of farm tractors stimulated the use of labor-saving machinery. Development of the power-take-off device, by means of which the husking mechanism is driven directly by the tractor, has made the machine more efficient and satisfactory under adverse ground and weather conditions. With the increased use of the mechanical picker more attention was given to its further development and improvement. The 2-row picker was placed on the market in 1928, and several new types of such machines have appeared since that year.

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[1] Acknowledgment is due M. A. Crosby, of the Division of Farm Management and Costs, for assistance in preparing the manuscript.

BASIS AND SCOPE OF THIS BULLETIN

This bulletin shows the elements of cost involved in husking corn by hand, with 1-row pickers, and with 2-row pickers, and the relative importance of these elements of cost, and indicates how the individual farmer can determine the most economical method of husking on his farm. It is based on data obtained from enterprise-cost records kept by 87 farmers who were using mechanical pickers in 1928, and 111 farmers who were operating pickers in 1929,[2] and from detailed cost records from 122 farms on which the corn crop was harvested by hand.[3] In these studies records were obtained showing the cash cost of husking with mechanical pickers and by hand, and the quantities of labor, power, and other materials used. Factors affecting the amount and distribution of costs and the relative advantages of each method are given and are used as a basis for determining the most economical and practicable method of husking on individual farms and under certain conditions.

These studies were conducted in Illinois; but, as studies made in Indiana and Ohio have been considered, it is believed that the data here given are generally applicable to the Corn Belt and to areas outside the Corn Belt if factors affecting the relative costs and advantages are considered.

TYPE AND COSTS OF MECHANICAL PICKERS

Mechanical corn pickers may be divided into two main classes, 1-row and 2-row machines. These classes may be further separated on the basis of source of power, mode of transportation, and method of loading the corn into the wagons. Not all these types were included in this study, for some have appeared on the market only very recently.

Pickers bought before the development of the power-take-off device were all 1-row machines pulled by horses, the husking mechanism being driven from a bull wheel or from an auxiliary engine mounted on the machine. Since the sale and use of this type is now very limited, little attention is given to it here. Records were secured on one hundred and two 1-row power-take-off machines and on sixty-four 2-row power-take-off machines. With one exception, all the power-take-off machines were pulled by the tractor, and on most farms the wagon was pulled alongside the picker by the tractor (fig. 1). Since these records were obtained a picker that is mounted on the tractor, with the wagon drawn directly behind, has become more common (fig. 2). The great advantage of this type is that no hand husking is necessary to open the field. The tank machine, eliminating the necessity for pulling a wagon around the field, is also a recent development (fig. 3). Both the tractor-mounted machine and the tank machine are made in 1- and 2-row sizes.

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[2] A cooperative study conducted by the Bureau of Agricultural Economics, U.S. Department of Agriculture, and the Department of Farm Organization and Management, University of Illinois.

[3] Records in Champaign and Piatt Counties, 1920–28, were kept in cooperation with the Department of Farm Organization and Management, University of Illinois.

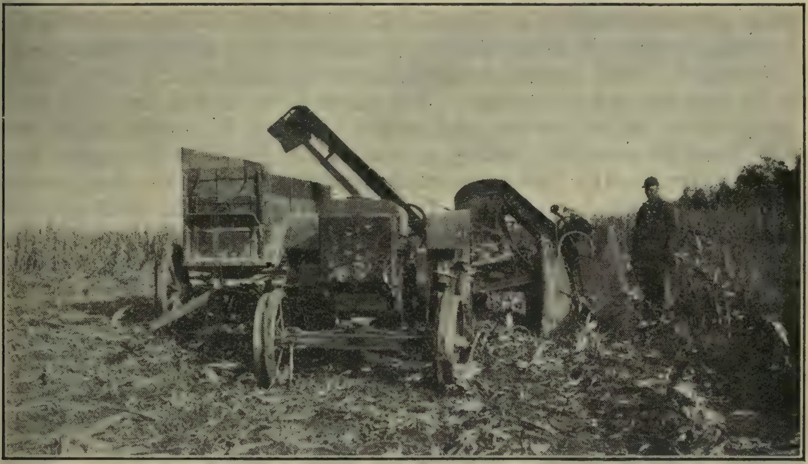

FIGURE 1.—The power-take-off device for operating the picker, and the hitch by means of which the wagon is pulled by the tractor, have made mechanical pickers more efficient.

The initial cost of the corn picker varies with the make and type. The cost of 1-row power-take-off machines equipped with a wagon hitch averaged about $425 on the farms studied, and the 2-row machines, about $625. All of the 2-row machines and over one half of the 1-row machines were bought in 1928 or 1929. Nearly all the other 1-row machines, however, were bought in 1925 or later.

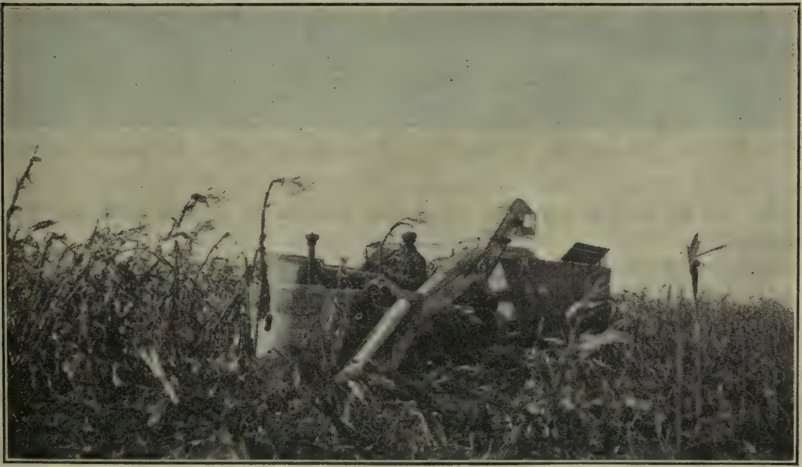

FIGURE 2.—The picker mounted on the tractor that pulls the wagon directly behind it eliminates the necessity for any hand husking to open the field

THE CORN-HUSKING SEASON

The time when corn husking is begun and the length of the husking season depend to a considerable extent on climatic conditions. Husking usually is started as soon as the corn is dry enough to be put in the crib; frequently the first corn husked is put in several different cribs to prevent heating and spoiling. In central Illinois hand husking normally extends from about the middle of October to the middle of December, with approximately three fourths of the crop in the crib by the first of December. An early frost and a dry fall make it possible to start sooner and make husking by hand easier and faster than is possible during a late fall. In 1928 an early frost and a relatively dry fall permitted over 96 percent of the husking in this area to be done by the last of November. In 1927 the first killing frost was 6 weeks later than in 1928, the rainfall was unusually heavy, and as a result less than one half the husking was done by the 1st of December, and over one fourth of it was delayed until January.

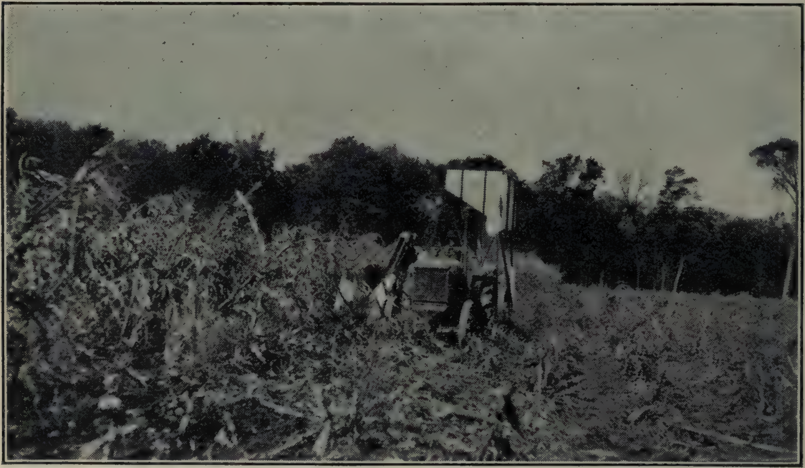

FIGURE 3.—The tank machine eliminates the necessity for pulling the wagon around the field.

One of the outstanding advantages of the mechanical picker is the possibility of beginning earlier in the season. Machine husking can be started from a week to 10 days earlier than hand husking. This is because a much greater proportion of the silk is removed from the ear by the machines than by hand huskers. Although under unfavorable conditions more husks may be left on the ear by the machine, the husks cause less damage than the silks when put in the crib.

Husking can also be completed much more quickly with equal amounts of labor when the machine is used. Ordinarily the labor on other crops is light during the corn-husking season, but the large acreage of corn grown on many Corn Belt farms and the limited period between the time when the corn can be cribbed and the beginning of winter make it necessary to finish husking in as short a time as possible. The use of the mechanical picker is an alternative to hiring the extra labor necessary to accomplish this when the corn is husked by hand.

SOURCE OF LABOR USED IN HUSKING CORN

The amount of labor hired for husking corn depends on the acreage of corn husked, the family labor available for husking, and the type of farming. On the farms studied in east-central Illinois, a grain-farming area, 70 percent of the labor in hand husking was hired. In west-central Illinois, a livestock area, the average acreage of corn per farm is smaller; a greater proportion of the acreage is hogged off or harvested for silage or fodder, and less labor is hired.

The mechanical picker enables the operator to more fully utilize his own and his family's labor and to be less dependent on hired help. On the farms where 1-row pickers were used in 1929, 68 percent of the total labor used in husking was that of the operator or members of his family; on the farms where 2-row machines were used, family labor made up 71 percent of the total. This saving in cost of hired labor must be balanced against the greater overhead cost and the cost of fuel, oil, and repairs involved in machine husking. The amount of labor that must be hired, which is determined by the amount of family labor available in relation to the acreage of corn husked, is therefore an important factor in determining the most economical method of husking on the individual farm.

EFFECTIVENESS OF HUSKING METHODS

The effectiveness of labor and equipment used in husking corn, or the quality of the work done, is usually measured by the quantity of corn left in the field and by the number of husks left on the corn. The corn left in the field may be in the form of whole ears that were missed, or kernels shelled by the snapping and husking rolls. On farms where there are cattle or hogs to pasture the fields after husking, a limited quantity of ear corn left in the field is not a great disadvantage if it can be cleaned up before winter weather prevents. The number of husks left on the corn is not particularly important, especially in the surplus corn-growing areas where most of it is later shelled and sold.

The husking rolls on the earlier machines shelled considerable corn, much of which was lost, but the newer machines save this corn and elevate it into the wagon. According to estimates of the operators, the average quantity of corn left by the 1-row machines was 1.35 bushels per acre and by the 2-row pickers, 2.14 bushels, about 75 to 80 percent of which was ear corn. These estimates are probably low since studies made by the Farm Mechanics Department, University of Illinois, in which corn left by both machines and hand huskers was picked up by hand and measured, shows an average of 5.9 bushels of corn left by the machines and 2.8 bushels by hand huskers. A similar study in Indiana shows an average of 3.38 bushels left in the field by 1-row pickers, 4.92 bushels per acre by 2-row pickers, and 1.24 bushels by hand huskers.

The quantity of corn left in the field by the machine depends on weather conditions, condition of the corn, and experience of the operator in adjusting the machine. Fewer ears are broken from the stalks and less corn is shelled when the stalks and husks are damp and tough than when they are dry, frozen, or rotten. The loss is, therefore, greater after several hard frosts and freezes or during a dry season—conditions that are favorable for fast and clean hand husking. The ability of the operator to adjust the machine properly, and to change the speed of operation to meet conditions, is important. The snapping rolls must be set close when the stalks are tough to prevent shelling or pulling the entire ear through the rolls. When the stalks are dry or frozen the rolls should be set farther apart to prevent breaking the stalks and elevating them into the wagon. The speed at which the picker is driven must be slower when the stalks are dry or leaning than when they are moist and standing upright. It is almost impossible to do a good job of husking when the stalks are down or leaning badly.

METHODS OF SAVING CORN LEFT IN THE FIELD

On the majority of these farms, corn left in the fields by mechanical pickers was salvaged by livestock or by hand picking. In hand picking, one man with a team and wagon saved an average of 2.7 bushels an hour. In most cases this was done by family labor after the corn was all husked and when there was little other productive work on the farm. Most of the ear corn left by the picker can be saved in this way, but that shelled is lost entirely unless the stalk ground can be pastured by livestock.

RELATION OF METHODS OF HUSKING TO TYPE OF FARM

Hand husking is a common method of husking corn on farms of all sizes and types. The possibility of hiring any number of extra men for hand husking makes this method so flexible as to fit conditions on almost any farm. Labor may be more difficult to obtain, and the cost higher on some farms and in some localities than others, but until recently no other method has proven sufficiently satisfactory to displace the hand husker. The farms from which records were obtained in east-central Illinois are typical of those in the surplus corn-growing areas.

Until recent years mechanical pickers have been most widely used on farms on which a relatively large acreage of corn has been grown or on farms on which other productive enterprises have demanded a large amount of time during the husking season. A survey conducted in 1928 by the Farm Mechanics Department, University of Illinois, showed that mechanical pickers were used on a larger percentage of farms in the dairy area in the northern part of the State than in the beef-cattle and hog area in west-central Illinois, or in the grain area in the east-central part of the State.

There may have been several reasons for this. The dairy enterprise by its very nature necessitates a short day in the field, thus making it essential to use labor-saving equipment. Then much of the hand husking is done by transient labor from areas south of the Corn Belt. The number of such laborers in the dairy area in northern Illinois usually is much lower than in the surplus-corn areas in east-central Illinois. This uncertainty of labor supply and the consequent higher rates in the dairy area induced the earlier adoption of machines for husking corn there. As some corn in the beef-cattle and hog area is hogged off, and some is cut and shocked, the regular labor force can handle a greater part of the corn to be husked from standing stalks without difficulty.

However, more mechanical corn pickers are now in use in the important surplus-corn-producing areas, where the former high cost of labor for hand husking made such labor-saving machinery popular with many farm operators. Nearly all the information on corn pickers was secured in such an area, where large farms on which 50 percent or more of the crop land is annually planted to corn are common.

The farms on which 1-row pickers were studied averaged 293 acres in size; those on which 2-row machines were used averaged 350 acres. Four 1-row machines were each owned jointly on two farms averaging 162 acres in size, and eight 2-row machines were owned jointly on farms averaging 201 acres.

ACREAGE OF CORN

An average of 142 acres of corn was grown on the farms on which 1-row machines were used and an average of 172 acres on those on which 2-row machines were used. Not all of this was husked in the field, nor was all that was husked in the field picked by machines. On some farms a small part was cut for silage or fodder or was hogged off. Usually a small part must be husked by hand to open the field for the machine, the amount depending on the size and shape of the fields. Extra men were hired to hand-husk 12 percent of the corn grown on the farms on which 2-row machines were used, and 26 percent of that where 1-row pickers were used. On some farms these extra men were hired late in the season when weather conditions and the condition of the corn made machine husking unsatisfactory; on others they were hired in the beginning in order to finish as quickly as possible.

An average of 96 acres of corn was husked by the 1-row machines on the home farms and an average of 137 acres by 2-row pickers. In addition, an average of 31 acres was husked on outside farms by each of five 1-row machines and an average of 60 acres by each of twelve 2-row machines. The total acres husked per season with 1-row pickers ranged from 32 to 275 acres, and with the larger machines from 30 to 338 acres. More than 80 acres each were husked by 70 percent of the 1-row pickers, however, and more than 120 acres each by 74 percent of the 2-row machines. It is evident that although the acreage of corn is important in selecting the method of harvesting, other factors were also considered on many of these farms.

SUPPLY OF LABOR, POWER, AND CAPITAL

At least 2 men are necessary for efficient machine picking, 1 operating the tractor and picker and 1 hauling and cribbing the corn. The number varies with the equipment. When a wagon hitch is used with the tractor to pull the wagon in the field and elevators are used to crib the corn, 1 man with 1 team and 2 wagons can haul the corn without delaying the 1-row picker, and with 2 teams and 4 wagons can usually do the same with the 2-row machines (fig. 4). Additional men are necessary if the distance to the field is great or if 1 man must drive the team while loading, or if the corn is scooped off by hand at the crib (fig. 5). A few operators of 1-row pickers had no one to haul and crib the corn; they loaded the wagons and then stopped the picker while they hauled and cribbed the corn. They used less total man labor in husking but the rate of husking was much slower as the picker was idle a considerable part of the time.

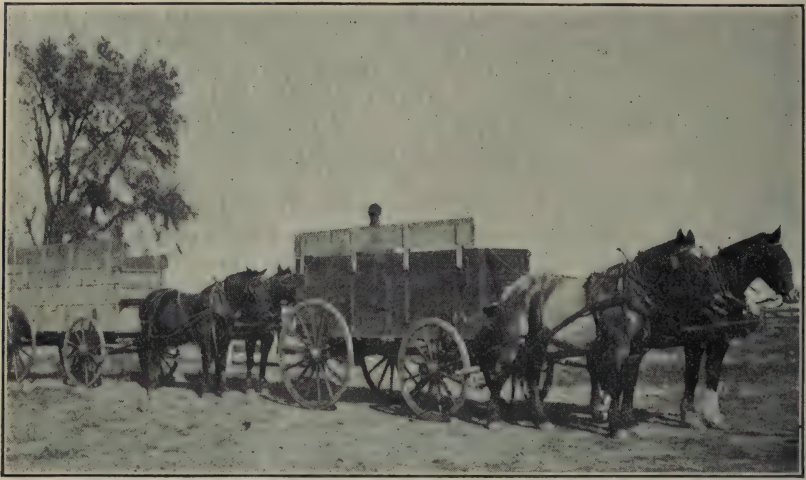

FIGURE 4.—One man with 2 teams and 4 wagons can haul corn from the field, leading 1 team behind the first wagon, and crib it as fast as one man can husk with a 2-row picker.

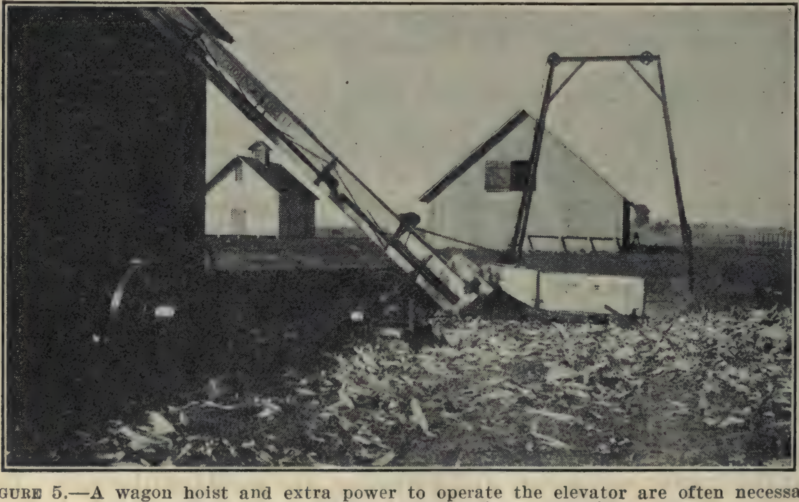

FIGURE 5.—A wagon hoist and extra power to operate the elevator are often necessary when one man hauls the corn from the field.

A tractor is necessary in using the modern power-take-off type of picker. Two-plow tractors were used to pull 71 percent of the 1-row pickers and 40 percent of the 2-row pickers; larger tractors were used on the others. Under most conditions the small tractor is satisfactory for the 1-row picker but does not have sufficient power to pull the 2-row picker and wagon when the ground is wet. On one farm, where a larger tractor was not available, 2 small tractors were used when the ground was wet, 1 pulling the picker and 1 the wagon. This permitted a faster rate of travel than if the wagon were pulled by a team.

The investment of capital necessary in the purchase of the mechanical picker is relatively large and, over a period of time, interest and depreciation on the picker must be considered as a farm-operating cost. Since these costs, once incurred, are fixed, the acreage of corn husked is an important factor in determining their relative importance. When spread over a large acreage, the proportionate part of these fixed costs to be borne by each acre or each bushel sinks to a low figure. Lack of capital or credit prevents many farmers, especially tenant operators, from using mechanical pickers. On other farms alternative uses for the available capital may determine the method of husking corn.

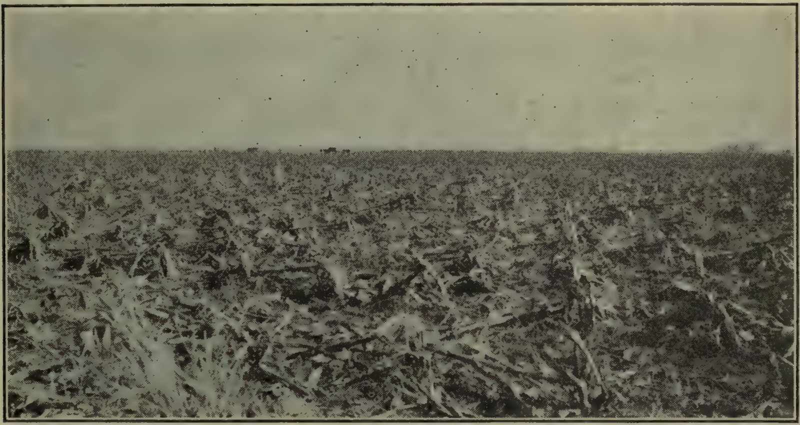

FIGURE 6.—Field of corn that has been husked by machine. Mechanical pickers break the stalks down more than hand huskers, but husking is completed earlier, giving more time for pasturing before winter weather.

OTHER FACTORS

Some land owners have objected to the use of mechanical pickers in the belief that the corn left in the field materially reduces the amount of rent they receive. On farms where the stalk fields are pastured extensively the machines are often objected to because the stalks are broken down more than when the corn is husked by hand so that much of the pasture value is lost (fig. 6). It is true that the stalks are broken down more, but it should be remembered that the earlier date at which husking is completed permits longer pasturing before severe winter weather.

CAPACITY OF LABOR IN HUSKING CORN

Two men in average corn can husk twice as much corn with a 1-row picker and three times as much with a 2-row machine, in an hour, as two men can husk by hand. The average rate of husking corn by hand in central Illinois is about 9 bushels an hour per man. In this study 2 men with a 1-row machine husked an average of 36 bushels per hour, and 2 men with a 2-row machine averaged 56 bushels per hour.

The rate of husking corn by hand depends on the yield of corn, on weather conditions, on type and quality of corn, and on the skill, ambition, and endurance of the husker. In machine husking the rate varies with the yield of corn, weather conditions, the condition of the machine, and the ability of the operator to keep the machine properly adjusted and going steadily.

An increase of 10 bushels in the yield of corn is found to result in an increase of about 0.8 bushel in the quantity husked in an hour by hand. This is an important factor since labor is much easier to get, and usually at a lower rate per bushel, when the yield of corn is high. More time is required to husk an acre, but this has little effect on the cost if the husker is paid by the bushel. Yield has little effect on the amount of time required to husk an acre with machines, but the quantity husked per hour increases with the yield. The yield of corn, therefore, is an important factor in determining the relative economy of hand or machine methods of husking.

Mechanical pickers may be operated at highest speed when the cornstalks are damp and tough. When the stalks are dry or frozen, and consequently very brittle, more ears are broken off and left on the ground, more corn is shelled by the snapping rolls, and more husks are left on the ears. Machine husking, therefore, is often slow and unsatisfactory under weather conditions which are ideal for hand husking. Conditions favoring machine husking usually prevail during the early part of the husking season, and the possibility of covering a large acreage soon after the corn is dry enough to be cribbed and before freezing weather often determines the degree of success of the mechanical picker and the acreage that can be handled in a season. Because of these limitations of the mechanical picker during the latter part of the husking season, hand huskers are often hired on farms where a large acreage of corn must be husked.

LABOR, POWER, AND EQUIPMENT USED IN HUSKING

The use of mechanical huskers involves the substitution of mechanical power and equipment for a large part of the man labor and horse work used where corn is husked by hand. An average of 5.23 man-hours, 10.19 horse-hours, and 5.10 hours of wagon use were used per acre in husking by hand on the farms studied. On farms on which 1-row pickers were used an average of 2.72 man-hours, 3.28 horse-hours, 2.86 wagon-hours, and 1.20 each of tractor- and picker-hours were used per acre, and on farms using 2-row pickers the quantities used per acre were 2.21 man-hours, 2.86 horse-hours, 1.97 wagon-hours, and 0.80 each of tractor- and picker-hours (table 1). The 2-row pickers used approximately 19 percent less man labor and 13 percent less horse work in husking an acre than did the 1-row pickers.

TABLE 1.—*Labor, equipment, and materials used per acre in husking corn by hand and by machines*

Item	Hand husking on 122 farms	One hundred and two 1-row pickers	Sixty-four 2-row pickers
Yield of corn, per acre ... bushels	48.8	43.0	45.0
Labor and equipment used:			
Man labor ... hours	5.23	2.72	2.21
Horse work ... do	10.19	3.28	2.86
Wagon ... do	5.10	2.86	1.97
Picker ... do	----------	1.20	.80
Tractor ... do	----------	1.20	.80
Materials used:			
Gasoline [1] ... gallons	----------	.78	.90
Kerosene [1] ... do	----------	1.55	.64
Oil [1] ... do	----------	.11	.08
Grease ... pounds	----------	.11	.04

[1] About 22 percent more fuel was used when 3-plow tractors were used with either 1- or 2-row pickers than when 2-plow tractors were used, but the size of tractor made little difference in the amounts of labor and power used.

To husk an acre of corn requires approximately 2.50 miles of travel with a 1-row picker and 1.25 miles with a 2-row machine. The average of 1.20 hours used in husking with a 1-row picker, and 0.80 hour with a 2-row picker represent an average rate of travel of 2.08 and 1.56 miles an hour, respectively. The time as given includes that spent in oiling, greasing, and making adjustments but does not include time spent in repair work.

The ability of the operator to care for and adjust the machine properly is important, and the amount of time spent on this work varies greatly. The machines should be given a thorough greasing and inspection twice a day, and some parts should be oiled even more frequently. Neglect of these essentials is likely to slow up the work. The yield of corn has little effect on the time required to husk an acre if the machine is in proper condition. On the farms studied less time was used per acre on farms on which a large acreage of corn was husked, but this probably was because of effective management in keeping the machines going rather than because of the larger acreage of corn per farm.

The number of men used in husking with mechanical pickers depends on the distance the corn is hauled, the method of pulling the wagon in the field, and the method of unloading at the crib. On many farms more men were used than necessary in hauling and unloading, frequently only because the help was available. Unless the speed of the picker is increased this abundance of labor does not increase the rate of husking.

FUEL AND OIL

The quantities of fuel and oil used vary with the size of the picker, the size of the tractor, and other factors such as adjustment of the picker and tractor and condition of the corn and ground. Average quantities of fuel and oil used for husking an acre are about one third less with a 2-row picker than with a 1-row machine (table 1). The distance the 2-row machine must travel is, of course, only one half as great as that which a 1-row picker must travel in harvesting an acre, but more power is required to operate the larger machine, and because of lack of power the larger machine often is operated at a lower speed than the 1-row machine.

About 22 percent more fuel is used in operating either the 1- or the 2-row picker with a 3-plow tractor than with a smaller tractor. The rate of travel is no greater in pulling the 1-row picker with a large tractor than with a small tractor but a somewhat higher speed is often possible when so pulling the 2-row machine. This advantage of the larger power unit is most apparent when the ground is soft.

COSTS OF HARVESTING CORN BY VARIOUS METHODS

The practical problem for the individual farmer is to select the method that is best and most economical under his particular circumstances. The system of farming that he is following, the acreage and yield of corn, the supply of regular labor available, and the prevailing level of prices and cost rates are factors that must be considered. The question is largely a matter of the relative costs involved in the different methods of doing the corn-picking job. These costs on an acre basis as averages for the farms in this study, are set forth in table 2.

TABLE 2.—*Cost of husking corn by hand and by machines, based on average quantities of labor, equipment, and materials used in eastern Illinois, seasons of 1928 and 1929*

Item	Hand husking on 122 farms	One hundred and two 1-row pickers	Sixty-four 2-row pickers
Acres husked per farm or per machine	98	105	159
Yield per acre ... bushels	48.8	43.0	45.0
Average cost per acre: [1]			
Hired labor	$1.88	$0.34	$0.26
Operator's and unpaid family labor	.81	.75	.63
Horse work	1.43	.46	.40
Tractor:			
Depreciation		.48	.39
Interest		.25	.21
Fuel and oil		.42	.29
Picker:			
Depreciation		.45	.44
Interest		.15	.13
Repairs		.09	.01
Shelter		.03	.02
Wagon use	.10	.06	.04
Elevator use	.24	.21	.23
Extra power at elevator		.05	.09
Total	4.46	3.74	3.14
Combined and classified costs per acre: [2]			
Direct cash costs	1.88	.90	.65
Unpaid costs	2.24	1.24	1.05
Depreciation	.34	1.20	1.10
Interest		.40	.34
Total	4.46	3.74	3.14

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[1] The following rates for labor, power, and materials were used to determine the cost of husking in 1928 and 1929: Man labor, 5½ cents per bushel for hand husking and 40 cents an hour for day labor; horse work at 14 cents an hour; tractor use, including depreciation, interest, and repairs, at 90 cents an hour for 3-plow tractors, and 50 cents an hour for 2-plow tractors; fuel, 13.4 cents per gallon for kerosene, 16.4 cents for gasoline, and oil at actual cost; wagon use at 2 cents per hour; elevator use at one-half

Two separate sets of figures are given for each method of husking. In the upper part of the table are given the various items of average cost such as hired labor, family labor, and tractor use, as determined in the study for hand husking, 1-row machine husking, and 2-row machine husking. In the lower part of the table these costs are combined and classified under several heads: (1) Direct cash costs, (2) unpaid costs, (3) depreciation, and (4) interest. Before discussing these costs, let us examine the classification of costs from the point of view of the significance of the different kinds of costs in helping to answer the farmer's question of how he ought to harvest his corn.

CLASSIFICATION OF COSTS

Under Direct Cash Costs are included all expenditures of money directly chargeable to the operation in question. For example, the fuel, oil, and hired labor used in running the mechanical corn picker, or the hired labor paid for by the bushel in the case of hand husking, are direct cash costs chargeable to the job of picking the corn. Under all circumstances, such costs have a direct influence upon the decision of the farmer.

The term "unpaid costs" is used to include those costs which are contributed by the farmer himself, by his family, or by the permanent elements in his farm organization that are used in the operation concerned—corn picking in this case—but for which he does not, at least immediately, pay out any money. Proprietor and family labor and the use of work stock regularly kept on the farm and which otherwise would not be in use during corn harvesting, are included in this group. The additional use of these resources does not necessarily increase the cost of operating the farm, and therefore these costs bear a distinctly different relationship to the problem of determining how to harvest corn from that of the direct cash cost.

Depreciation is similar to the unpaid costs, and might logically be included with them on farms where the equipment is already owned. Depreciation represents a cash outlay made in some previous period, but once the equipment is bought, depreciation does not represent an immediate cash outlay incurred directly and exclusively for the operation concerned. Furthermore, some depreciation takes place through weathering and obsolescence even when equipment is

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(Footnote [1] continued)

cent per bushel. Depreciation on the picker was calculated according to the following formula:

$$\frac{\text{Cost of machine} \times \text{acres husked}}{\text{Average life of machine (acres)}} = \text{annual depreciation}$$

Interest on the picker was charged at 6 percent on the average valuation during its expected life, determined as follows:

$$\frac{\text{Cost of machine} \times \text{average life of machine (years)} + 1}{\text{Average life of machine (years)} \times 2} = \text{average valuation}$$

The average life of the 1-row picker was estimated at 10 years, or 950 acres; that of the 2-row machine at 8 years, or 1,400 acres. Repairs on the pickers were charged at actual costs. In comparing the cost of repairs on the 1- and 2-row pickers it should be remembered that all the 2-row machines were 1 or 2 years old while many of the 1-row machines were 3 or 4 years old. Shelter charges were estimated at $4.20 a year for the 2-row pickers and $3.50 for the 1-row machines.

[2] Direct cash costs include hired labor, fuel and oil, and repairs on the picker. Unpaid costs include operators and other unpaid family labor, horse work, and shelter for the picker. Depreciation includes depreciation on the tractor and picker, and use of wagon and elevator. Interest includes interest on the tractor and picker.

not used. As depreciation is an important cost factor in the use of mechanical pickers and tractors, it seems well to separate it (table 2).

Finally there is the interest which might also be considered an unpaid cost but which, for the sake of making the picture a little clearer, is put in a separate classification. The purchase of new equipment increases the amount of capital on which interest must be paid or from which some return may be expected. But the additional use of equipment already on the farm does not increase the interest charge on that machine.

USE OF COSTS IN SELECTING A METHOD OF HUSKING CORN

Table 2 may be used in an effort to find a basis for the decision as to the most economical method of harvesting corn. In terms of the average costs, as found in this study for the year in question, the table shows that it cost $4.46 per acre to have the corn husked by hired pickers at the rate of 5½ cents per bushel. It cost $3.74 per acre at the prevailing prices of gasoline, oil, and other cost elements to have it picked by a 1-row mechanical picker, or $3.14 by a 2-row machine. These gross acre costs include all of the classes of costs already discussed.

They do not necessarily give a conclusive answer to the farmer's question as to how he should harvest his corn, nor that he should, under those circumstances, pick his corn with a 2-row machine, since the total costs by that method are lowest.

In the first place, current conditions with reference to cost rates have changed drastically since these figures were gathered. First of all, the farmer must take these changes into account. In the second place, the answer partly depends on whether he is considering the use this year of a machine he has previously bought and has on his farm ready for use, or whether he must buy a machine in order to use the mechanical method.

Suppose that he has a machine and is trying to settle whether he should use it this year. The gross acre-cost figures would indicate that he is particularly fortunate if he has a 2-row picker; that the next cheapest method would be a 1-row picker; and that the most expensive method would be to hire it done by hand at bushel rates.

But he should look at the items showing the different classes of costs. In a period like the present it is particularly important that cash costs be kept at a minimum. The "direct cash cost" item also shows that he would have to pay out the most cash to have it picked by hand and the least by having it picked by a 2-row machine. On the basis of immediate cash expenditure, therefore, it is obvious that if a man has a picker he should use it. Here, again, current rates of cost must be considered rather than those that obtained when this study was made.

But suppose now that he is trying to decide whether to buy a picker. He must then consider not only the cash costs but depreciation and interest on the new equipment, and depreciation on other equipment, because all of these additional costs are still within his control. Looking again at the average figures in table 2, it is evident that if he includes cash costs, plus depreciation, and interest, all of which will be affected by his decision to buy or not to buy a picker, the cost for hand picking is $2.22 per acre; for 1-row-machine picking, $2.50; and for 2-row-machine picking, $2.09. So far as these figures go, therefore, it would still appear to be most economical to buy a 2-row machine instead of hiring the corn picked by hand at bushel rates. But, again, he must think of the current conditions. During 1931 and 1932 he could probably have found hand huskers who would work at the low rate of 3 cents per bushel and, although the cost of day labor would also have been less, the other items such as gasoline, oil, and the original purchase price of machinery would not have fallen nearly so much. A refiguring of these costs on the basis of current rates would make a much less favorable showing for the mechanical huskers.

But these costs are not the only considerations he must take into account in making his decision. Even though it looks as though he might well buy a picker, he may not have the cash or credit with which to buy it, or he may be able to use his available cash or credit to greater advantage in some other way. He also may not wish to invest his limited capital in a machine like the corn picker, that will bring its returns and services only over a period of several years and the economic advantage of which depends so much on the relative prices of labor and materials.

Moreover, he has not yet considered the so-called unpaid costs which are mainly family and proprietor labor. Such costs enter into the consideration in a way quite different from direct-cash costs, and even depreciation and interest. Their importance in his decision rests largely on the value of the alternative uses he may have for this labor. It is possible that he may use his own labor more than normally by prolonging the corn-husking season, thus avoiding not only the buying of a machine but the hiring of hand huskers as well. The wisdom of this depends upon a number of considerations such as the alternative use he may have for this unpaid labor and the risk of loss he is running by prolonging his corn-harvesting season into the winter months. It is true that costs representing unpaid labor must be met in the long run if farming is to be profitable, but in the immediate situation the farmer frequently uses this unpaid labor, without the hope of getting a full normal return for its use, merely because if he did not use it he would be getting nothing for it, and he wisely decides it is better to get something, although it is a small return, than to get nothing.

Thus it seems clear that cost figures alone are inadequate as a basis for determining the best method of husking corn or for the performing of any other farm operation. They are important, however, in that they furnish indispensable information which, together with the knowledge of the operator and information from other sources, forms a basis for the farmer's judgment.

FACTORS AFFECTING COSTS OF HUSKING

To illustrate further the considerations that have been discussed and to indicate how the individual farmer may determine which of the available corn-harvesting methods he will use on his own farm table 3 is given. The estimated quantities of labor, power, and other materials necessary, and the costs of husking corn on one farm by different methods, are shown. The costs are first shown itemized and are then grouped according to the classifications discussed. (See table 2.)

TABLE 3.—*Estimated quantities and costs of labor, power, and materials for husking 112 acres of corn by different methods and under specified conditions*

[Average yield of 50 bushels per acre; only the operator is regularly on the farm at this season, but labor is available at 5½ cents per bushel for hand husking or 40 cents an hour for day labor]

Item	Hand husking		1-row picker		2-row picker	
	Quantity	Cost	Quantity	Cost	Quantity	Cost
	Bushels	*Dollars*	*Hours*	*Dollars*	*Hours*	*Dollars*
Hired labor	3,850	211.75	135	54.00	90	36.00
Operator's labor	1,750	96.25	150	60.00	100	40.00
	Hours					
Horse work	1,204	168.56	270	37.80	360	50.40
Tractor:						
Depreciation				[1] 97.20		[2] 64.80
Interest				24.30		16.20
			Gallons		*Gallons*	
Fuel			302	40.47	186	24.92
Oil			11	8.25	9	6.75
Picker:						
Depreciation				[1] 50.10		[2] 50.00
Interest				14.02		21.12
Repairs				10.00		10.00
Shelter				3.50		4.20
Wagon use [3]		12.04		5.40		7.20
Elevator		28.00		28.00		28.00
Total		516.60		433.04		359.59
Combined and classified costs:						
Direct-cash costs		211.75		112.72		77.67
Unpaid costs		264.81		101.30		94.60
Depreciation		40.04		180.70		150.00
Interest				38.32		37.32

[1] Estimated cost of use for 135 hours.
[2] Estimated cost of use for 90 hours.
[3] Wagons used 602 hours for hand husking, 270 hours with 1-row picker, and 360 hours with 2-row picker.

This is a 200-acre farm with 120 acres in corn yielding 50 bushels per acre. Typical of many grain farms in the Corn Belt, only the operator is on the farm regularly at this season of the year, but hired help is available for hand husking at 5½ cents per bushel and day labor at 40 cents per hour. A 3-plow tractor and the normal number of work horses are on the farm. In order to open the fields for the mechanical husker, about 8 acres will be husked by hand, so costs are estimated for the remaining 112 acres of corn.

If the corn is to be husked by hand, the operator may estimate that he can husk 35 acres, or 1,750 bushels, leaving 77 acres, or 3,850 bushels, to be husked by hired help. The farm is so arranged that the corn must be hauled only a short distance to the crib and, with the elevator, 1 man with 1 team and 2 wagons can haul the corn without delaying the 1-row picker and with 2 teams and 4 wagons, without slowing up the 2-row machine. With the 1-row picker he can hire 1 man and husk the entire 112 acres in about 17 days. With 1 man and the 2-row machine he will use about 12 days.

Under these conditions the estimated cost of husking the corn by hand is $4.61 per acre; the cost with a 1-row picker is $3.87 per acre; and with a 2-row machine, $3.21.

But these figures are not conclusive evidence of the economy of the mechanical picker on this farm. There is no other work on the farm at this season at which the operator may profitably use his time and the horses. These items of unpaid costs, therefore, may be disregarded for the present. Direct cash costs also show the machines to be more economical than hand husking, amounting to $1.89 per acre when husked by hand, $1.01 per acre when husked with a 1-row picker, and $0.69 when a 2-row machine is used. When depreciation on the tractor, picker, and wagon, and elevator costs, and interest on the picker are added to the cash costs, however, the cost of hand husking is $2.25 per acre, the cost with a 1-row picker is $2.96, and with a 2-row machine is $2.36 per acre. If only cash costs and depreciation are considered (as might be feasible when a mechanical husker is owned and the question is whether to use it or not), the cost of husking with the 2-row machine is slightly lower than the cost of husking by hand.

The economy of using a mechanical picker on this farm is at least questionable. On some farms other enterprises will demand sufficient time during this season so that a picker will reduce materially the amount of labor that would be hired if the corn were husked by hand. On some farms the regular labor can be used profitably during the time saved through the use of the machine. The regular labor and the picker may be used in doing custom work by which the overhead cost on the home farm is reduced and the farm income increased. In some cases the final decision may be made on the basis of the farmer's likes and dislikes.

The costs of husking on this farm as estimated in table 3 assume certain conditions to exist. How are the relative costs of husking by different methods affected by variations in these conditions? The effect of certain changes is shown in table 4.

Table 4.—*Effect of variation in certain factors on the cost of husking 112 acres of corn shown in table 3*

Item	Cost per acre as estimated in table 3			Case 1. Effect of changes in number of men regularly on the farm			Case 2. Effect of changes in yield of corn			Case 3. Effect of changes in labor rates			Case 4. Effect of changes in corn acreage		
Acres of corn	112			112			112			112			50		
Yield of corn per acre bushels	50			50			30			50			50		
Regular men on farm number	1			2			1			1			1		
Labor rates:															
Hand husking per bushel cents	5½			5½			5½			3			5½		
Day labor per hour cents	40			40			40			25			40		
	Hand	1-row picker	2-row picker	Hand	1-row picker	2-row picker	Hand	1-row picker	2-row picker	Hand	1-row picker	2-row picker	Hand	1-row picker	2-row picker
Classified costs per acre:															
Direct cash costs	$1.89	$1.01	$0.69	$1.03	$0.52	$0.37	$0.94	$1.01	$0.69	$1.03	$0.83	$0.57	$0.82	$1.02	$0.70
Unpaid costs	2.36	.91	.85	3.22	1.39	1.17	.82	.90	.62	1.97	.70	.72	3.43	.93	.89
Depreciation	.36	1.61	1.34	.36	1.61	1.34	.23	1.51	1.21	.36	1.61	1.34	.36	1.72	1.89
Interest	-----	.34	.33	-----	.34	.33	-----	.34	.33	-----	.34	.33	-----	.50	.57
Total	4.61	3.87	3.21	4.61	3.86	3.21	1.99	3.76	2.85	3.36	3.48	2.96	4.61	4.17	4.05

Suppose, as in case 1 in table 4, there are 2 men on the farm regularly instead of only 1. The amount of hired labor necessary for hand husking is greatly reduced, and none is required in husking with the machine. The total cost is not affected since the unpaid labor is figured at hired labor rates, but the cash costs are materially lower, particularly in the case of hand husking where labor makes up a large part of the total cost. The cash costs are still in favor of the mechanical pickers, but when depreciation is considered with cash costs, hand husking is by far the most economical method.

In case 2, table 4, a yield of 30 bushels per acre is assumed, with other conditions as they are in table 3. With the lower yield per acre the number of bushels that can be husked per hour by hand is reduced, but more acres can be husked during the season, thus reducing the proportion that is husked by hired labor. As the yield of corn has little effect on the number of acres husked with the machines, the only difference in the cost of husking is the lower charge for the elevator. When the total costs, or when cash costs plus depreciation, are considered, hand husking is by far the most economical method under these conditions. Hand husking is more economical than husking with the 1-row picker when cash costs alone are considered.

The lower rates for labor which now prevail have been mentioned as an important factor in determining the relative costs of husking by different methods. In case 3, table 4, the costs are estimated under conditions when hand huskers can be secured for 3 cents a bushel and day labor for 25 cents an hour. The cost of hand husking is reduced more, proportionately, than the cost of machine husking because of the greater importance of labor in determining the total cost. The total cost of hand husking is lower than using the 1-row picker but the cash cost is higher.

In case 4, it is assumed that only 50 acres of corn are husked. The total cost per acre of hand husking in this case is the same as when 112 acres were husked since the overhead is reduced directly with the acreage. The cost when the machines are used is higher than on the larger acreage since much of the overhead cannot be reduced. The total cost per acre on the 50-acre job is slightly higher when the corn is husked by hand, but cash costs are lower than when a 1-row machine is used, and when depreciation is considered the costs are greatly in favor of hand husking.

No attempt is made here to indicate all the different situations that might influence the relative costs of husking by different methods. The examples given will serve to show how the individual farmer can make some estimate of the relative costs on his farm, taking into account the factors that have been mentioned as well as any others that he believes should be considered.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1716

MOLE CONTROL

1862 1888

MOLES carry on their underground work unnoticed by man until their telltale ridges and mounds have disfigured lawns, damaged golf courses, or ruined seed beds in the garden or nursery. When such evidences of damage are first noticed, control measures should be undertaken on the affected area as promptly as possible.

Unlike rodents, moles live chiefly upon earthworms and insects that inhabit the ground. To the extent that they destroy harmful insects they are beneficial, and no control campaign should be carried on against these insectivorous mammals on areas where their burrowing does no damage.

This bulletin includes instructions for combating the ravages of the three eastern species and also gives specific directions for trapping the larger Townsend's mole of the Pacific Coast States. It supersedes Farmers' Bulletin 1247, entitled "American Moles as Agricultural Pests and Fur Producers".

Washington, D.C. November 1933

MOLE CONTROL

By JAMES SILVER, *associate biologist, and* A. W. MOORE, *junior biologist, Division of Predatory Animal and Rodent Control, Bureau of Biological Survey*[1]

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WHERE MOLES ARE FOUND

WITHIN THE BOUNDARIES of the United States are five groups of true moles. Two of these are confined to the Pacific coast, and three are distributed over the section mostly east of the one-hundredth meridian, extending from Canada to the Gulf of Mexico (fig. 1). No moles are known in the Great Basin and the Rocky Mountain regions, nor in the western parts of the Great Plains. The common mole of the eastern part of the United States (*Scalopus aquaticus*) may be found almost anywhere south of New England, New York, Michigan, and central Minnesota, except in the mountain regions. In the latter districts and in the greater part of Pennsylvania, New York, New England, and to the northward the common mole is replaced by the star-nosed mole (*Condylura cristata*) and

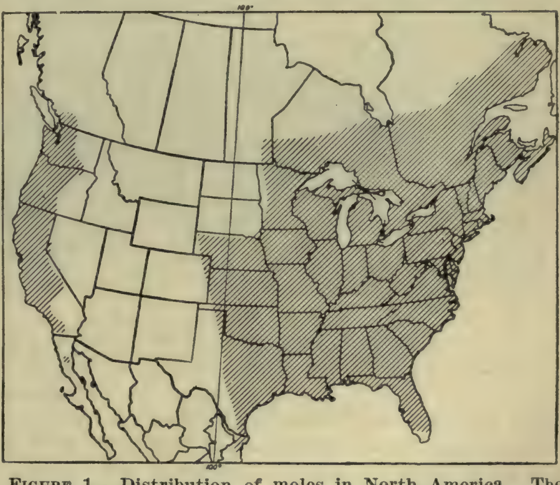

FIGURE 1.—Distribution of moles in North America. The Pacific coast area includes the ranges of Townsend's and Gibbs' moles (*Scapanus* and *Neurotrichus*) ; in the eastern area are the common mole (*Scalopus*), star-nosed mole (*Condylura*), and Brewer's mole (*Parascalops*).

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[1] Acknowledgment is made to Theo. H. Scheffer, associate biologist, author of Farmers' Bulletin No. 1247, American Moles as Agricultural Pests and as Fur Producers, prepared in 1922, large parts of which have been used in the preparation of this bulletin.

Brewer's mole (*Parascalops breweri*). The largest mole on this continent is Townsend's mole (*Scapanus townsendii*), of the Pacific Coast States. Moles of the genus *Scapanus* are more abundant in this region than are any other moles there or elsewhere in the United States. Gibbs' mole (*Neurotrichus gibbsii*), another west-coast form, is somewhat rare and so small as ordinarily to escape notice.

The general distribution of moles seems to depend largely upon atmospheric humidity and the resulting condition of the soil. They are absent altogether from arid regions, and where the prairies of the Middle West merge gradually into the Plains they are found only along watercourses. In these regions of deficient rainfall the ground is so dry and hard during the greater part of the year as to be wholly unsuited to the existence of earthworms and insect larvae, upon which the mole depends for subsistence. In the East moles are most abundant in moist, rich soils along streams, particularly if these situations are somewhat shaded. In the cooler, more uniform climate of the Pacific Northwest they are plentiful anywhere in the well-watered valleys.

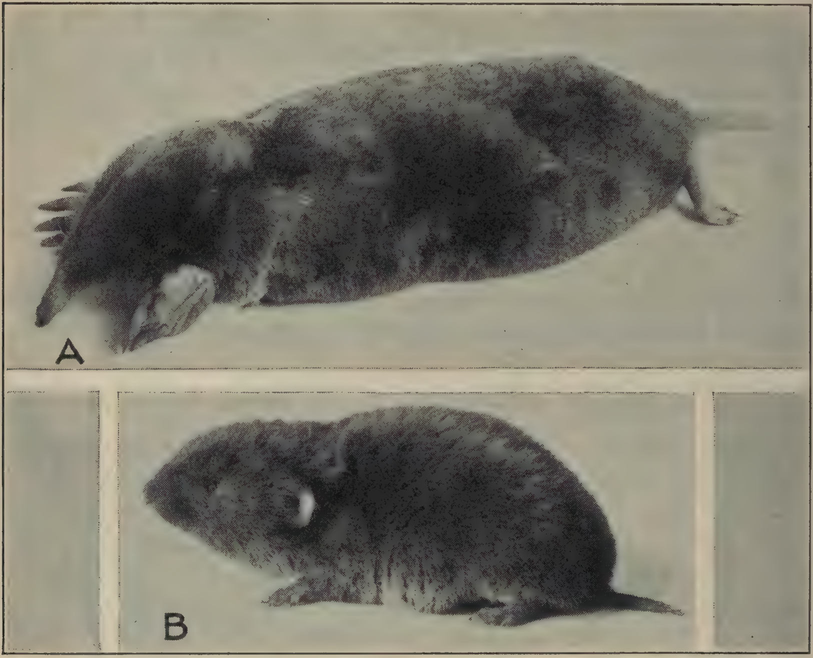

FIGURE 2.—Comparison of the mole (*A*) and a member of the rodent order (pine mouse) (*B*). Broad, rounded hands turned outward, pointed snout, and practical absence of eyes serve to distinguish the mole from mice, rats, and other rodents.

DESCRIPTION OF THE MOLE

So seldom is the mole seen, even by those familiar with its work, that it is often confused with other small creatures, particularly the shrew, the vole (or meadow mouse), and the pocket gopher. From the pocket gopher the mole is readily distinguished by the absence of cheek pouches and by its less conspicuous eyes. The mole is not a rodent, and can be readily distinguished from any of this order and from the shrew by its short, stout, front limbs, ending in broad, rounded hands with strong claws and with palms turned outward; it has a rather elongated body, close, plushlike fur, a pointed snout, and a short tail (figs. 2 and 3). Neither external eyes nor ears are ordinarily in evidence. If not totally blind, the common mole of the eastern part of the United States can at best merely distinguish between light and darkness, as what remains of its organs of sight lies wholly beneath the skin. The degeneration of these organs has apparently not proceeded so far in Townsend's mole, which usually opens its eyes when annoyed by an observer. The eyes of the star-nosed mole also are readily discernible.

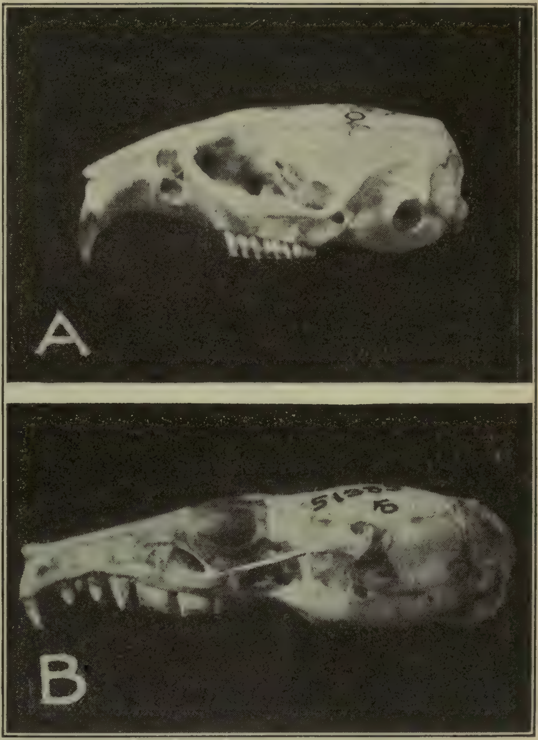

FIGURE 3.—The difference in shape of head and arrangement of teeth in moles and in rodents is readily observable in these typical skulls: *A*, Skull of field mouse (*Microtus*); *B*, skull of mole (*Scalopus*). Both are enlarged to twice natural size.

HABITS

The mole lives mostly underground. Such experiences as fall to its lot must necessarily come through its sensitive touch, acute hearing, or highly developed powers of smell. While the animal is seldom seen aboveground, it sometimes ventures out of its tunnels, perhaps chiefly at night.

RUNWAYS AND NESTS

When a mole is living in lawns, gardens, or fields, telltale ridges or conspicuous mounds of earth (figs. 4 and 5) plainly indicate its runways. The ridges show the direction and course of the animal's hunting paths, which are so close to the surface that the sod or the soil crust is raised. The mounds indicate deeper tunneling, for they are formed of earth pushed up from lower workings, where the soil is too compact to be simply crowded aside. Such mounds thickly dot the mole-infested areas of the Pacific coast country. They are of much rarer occurrence in the habitat of the common eastern species, but the star-nosed mole regularly uses this method to dispose of dirt displaced from its tunnels. The number of mounds or ridges in a field does not indicate the number of moles present; one Townsend's mole, for instance, in a period of 77 days constructed 302 mounds on a quarter-acre field.

The mounds of Townsend's and other moles of the west coast resemble superficially the earth heaps thrown up by pocket gophers, but usually they can be distinguished from the latter by even casual inspection (fig. 6). The mole heaps are the more rounded and symmetrical and are built up, volcano fashion, by successive upheavals beneath and through the center of the pile, the soil that is thus excavated rolling down the sides from the summit. The pocket gopher, on the other hand, brings up the soil excavated in its workings and dumps it on the surface in armfuls, thus forming low, semicircular, or fan-shaped, accumulations of fine dirt more or less to one side of the burrow exit.

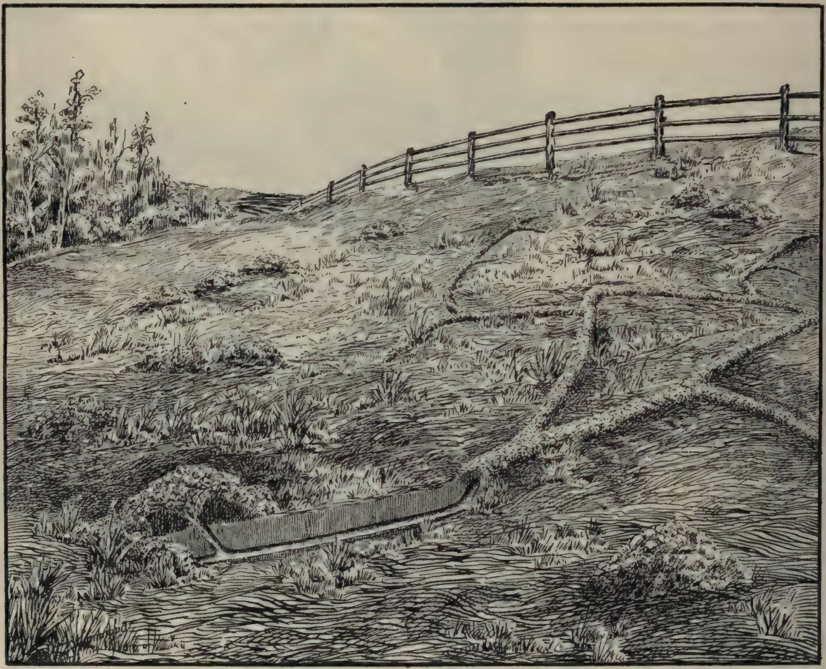
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FIGURE 4.—Ridges and mounds made by moles. The sectional view shows part of a deeper runway connected with the mound and with a subsurface hunting path.

The more permanent tunnels of the mole commonly run along fences, hedges, walks, plant rows, and the ridges of open fields. Such situations are frequented by the mole because they afford some concealment or shelter and especially because they are less often disturbed by the activities of man. These burrows vary in depth from only 1 or 2 inches to levels beneath the reach of the plow. They constitute a labyrinth of runways, constructed with apparently no definite plan and including here and there an enlargement. One r more of these enlargements may, especially in the breeding seaon, contain a nest of half-dried grass or of grass and dead leaves.

Certain galleries or passages leading out from the deeper central ystem trend upward here and there to join the shallow subsurface uns that stretch out over the mole's hunting grounds (fig. 4). 'hrough these runs the little animal hurries along at irregular interals in search of food and, when occasion demands, extends the imits of its operations by pushing out into untouched soil.

The movements of the mole as it extends the subsurface runways re much like those of a man swimming with the breast stroke. 'he mole's hands are brought forward, palms outward, until they lmost or quite touch in front of the snout. With powerful action f the heavy shoulder muscles they are then thrust outward and ackward to push the soil aside, while the body follows in the assageway thus created. The snout is a sensitive organ of touch nd is not used for rooting.

IGURE 5.—Mounds characteristic of moles in the Pacific coast region. These thickly dot the areas infested by Townsend's mole in Washington and Oregon. Mounds are rarely made by the common eastern mole, but they are regularly pushed up by the star-nosed mole.

ACTIVE PERIODS

Direct observations fail to show that there is any one time of day hen the mole is more active than at others, in spite of the common elief that it works only at regular periods each day—morning, oon, and evening, as most frequently alleged. If an opening is nade into a mole's runway the animal when it next comes that way vill invariably repair the breach. By taking advantage of this habit one can gain much information if he will visit, at short inter-vals through the day, each of a number of runs in which a small break has been made. A large number of runs have thus been kept under observation for periods of several days at a time, with results indicating that moles are as likely to be found working at one hour of the day or night as at another, especially at seasons when there is no great variation in temperature throughout the period of 24 hours.

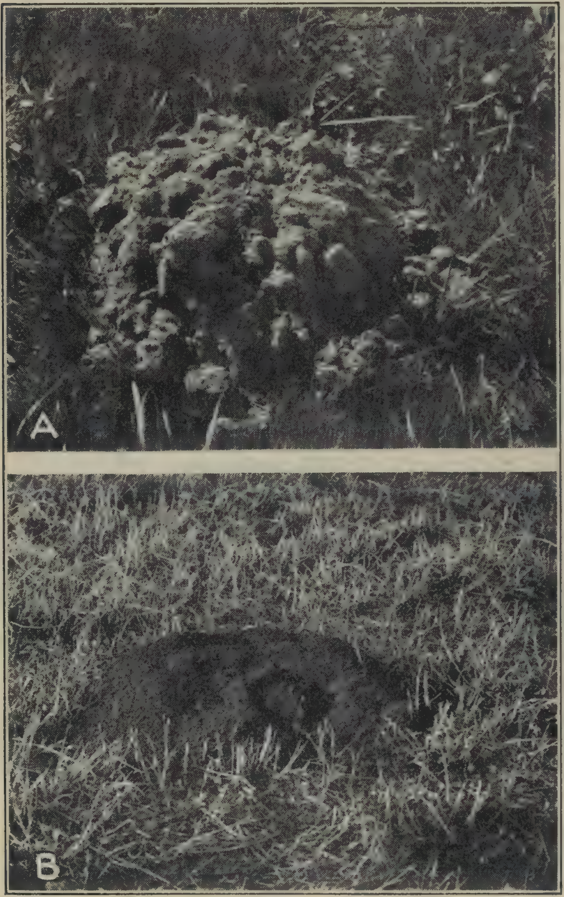

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FIGURE 6.—*A*, Mound of western mole; *B*, mound of pocket gopher. The former is the more symmetrical, being built up volcano fashion by upheavals through the center. The latter is fan shaped, thrown out to one side of the burrow exit.

As to seasonal activity, it may be said that moles probably never become dormant. They extend their surface runways, however mainly at times when soil conditions are favorable—after rains in summer or during periods of thaw in winter. At other times in their search for food moles must use their old runs or work at depths and in situations unaffected by frost or drought Movements of soil inhabiting worms and insects, including larvae, tend to bring ever fresh supplies of food into these tunnels.

BREEDING HABITS

Contrary to popular opinion, moles are slow breeders Their life of seclusion shelters them from many of the dangers that constantly threaten the existence of the small mammals living aboveground. To maintain their normal numbers from generation to generation, a rapid rate of increase therefore, is not necessary. The young are brought forth early in the spring in rudely constructed nests of half-green grass stubble and rootlets. The number in a litter of Townsend's mole is commonly three; the common eastern mole usually has four.

Moles grow and develop with surprising rapidity. In the Northwest most of the young are born in the latter half of March and the first half of April, spend about a month in the nests, and early in June are so well grown as not ordinarily to be distinguished from the parent moles. This rapid growth accounts for the fact that small young moles are seldom trapped. By the time they leave the home nest and take to the runways for themselves they have already attained something like the size and proportions of adults.

FOOD HABITS

A mole's appetite seems to be almost insatiable. When held in captivity and given food to its liking, one will sometimes eat more than its own weight in a day. The large quantity of food thus required is no doubt due to the intensely active life the little animal leads. Few other mammals are relatively as strong or do as much hard work in a day.

The mole's food, which has been the subject of much discussion, generally consists of adult insects and their larvae, and earthworms. Examination of 200 stomachs of the common eastern mole, taken in all months of the year, has demonstrated that earthworms and white grubs constitute the bulk of the food. Beetles and their larvae, other ground-inhabiting insects and their cocoons and puparia, spiders, centipedes, and some vegetable matter also are included in the eastern mole's diet.

Townsend's mole also lives largely on earthworms and larval and adult insects, but it takes a considerably greater quantity of vegetable matter than does the eastern mole. Townsend's mole eats tulips, tigridias, bulbous iris, carrots, parsnips, potatoes, peas, beans, vetch, oats, corn, and wheat, and these often form substantial portions of its fare. Of 45 stomachs of this mole analyzed in the laboratory of the Division of Food Habits Research, Bureau of Biological Survey, 25 contained vegetable matter varying from a trace to 100 percent. This mole shreds the large tubers and bulbs with its strong front feet and then works the shreds into its mouth. Smaller roots, such as carrots and parsnips, are readily chewed up, the mole's mobile snoutlike nose being easily bent out of the way. As the mole's short teeth are not well suited to gnawing, the damaged roots are mangled but not cut clean (fig. 7).

ECONOMIC STATUS OF THE MOLE

Through the ages moles, in common with other burrowing animals, have undoubtedly played an important part in the evolution of the soil. By constantly moving and stirring it, bringing up subsoil, and carrying down organic matter from the surface, they have contributed to the natural building up of soil fertility. With man's occupancy of the land, however, the value of the mole as a cultivator ceases; the natural process is much too slow.

Under some conditions moles may not prove objectionable, and through their consumption of harmful insects—cutworms, white grubs, and other species—they may be decidely beneficial. In the vast areas of uncultivated and waste lands they are in nowise injurious and should be left unmolested, to carry on their function in Nature's scheme.

In cultivated areas, however, moles may seriously interfere with man's use of the soil, and in making their mounds and runways they often disfigure lawns, damage golf courses, and ruin seed beds in gardens and nurseries. They cause damage in cornfields (fig. 8), gardens, and flower beds by consuming seed corn and plant roots and also by traveling along the rows, heaving the plants out of the ground, and causing heavy crop losses by thus cutting off the moisture supply and injuring the roots. Mounds raised by moles in hayfields break or quickly dull the knives of the cutter bar of the mower or else necessitate raising the bar so much as to greatly reduce the crop.

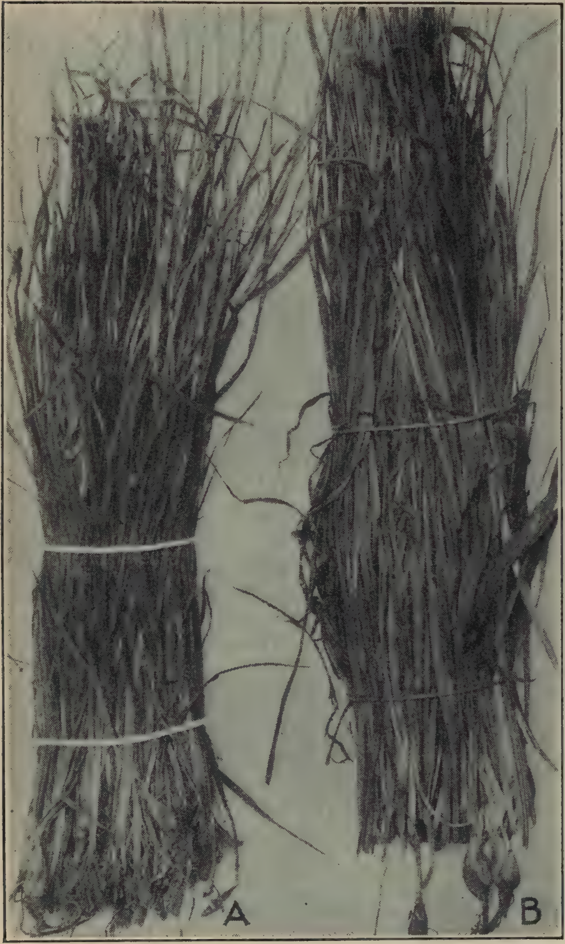

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FIGURE 7.—Tigridia stalks (*A*) mangled by moles in removing the bulbs, and (*B*) cut clean by pocket gophers.

Observations have indicated that the mole is also a potential carrier of plant pests and diseases, and the mole's work may seriously increase the damage during such outbreaks. In the Pacific Northwest it was noted in one case, for instance, that damage to bulbs in a disease area was most severe where the plants had been undermined by Townsend's moles. In scratching or eating infected bulbs or roots and then going to healthy plants these animals may spread disease organisms, such as the mosaic virus and other bacteria or spores as well as injurious nematodes. Through loose soil one mole may easily travel 100 yards a day, and strict sanitation in the bulb industry may thus be nullified.

TRESPASSERS IN MOLE RUNWAYS

The mole is not permitted to enjoy undisputed occupancy of the underground galleries that its industry has constructed. Certain other small mammals, particularly shrews, voles or meadow mice, and sometimes ordinary house mice, rats, and pocket gophers, find these tunnels convenient highways for traffic and marauding. As a result of this trespassing the reputation of the mole suffers, for it is blamed for much of the injury to seeds, grains, tubers, and roots of cultivated plants, that is chargeable to these intruding rodents. A study of tooth marks on the damaged products (fig. 7) or the systematic trapping of the intruders will bear out this statement. In the East, Middle West, and West, counts of the occupants of mole runs have shown that the trespassers are often more numerous than the moles.

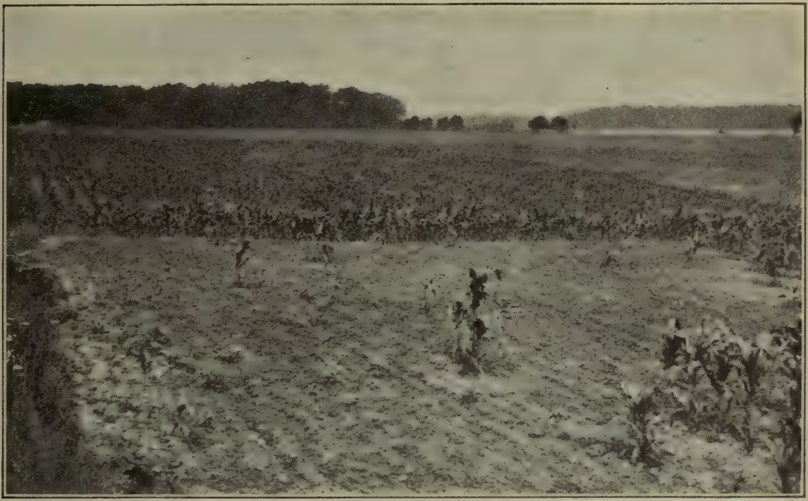

FIGURE 8.—Injury to corn resulting from a heavy infestation of moles at Osgood, Ind.

NATURAL ENEMIES AND CHECKS

On account of its secluded life the mole is little subject to attacks by the many foes of other small mammals. Its burrow is so small that no formidable enemies except, perhaps, small weasels or snakes can follow it underground, and as it seldom leaves its passageways there is little likelihood that it will be seen by predatory animals. When a mole is working near the surface, however, the movements of the soil may readily be detected by a watchful foe, and it is probable that those taken by hawks and owls and by other hungry denizens of the wild are seized when these watchful creatures notice a disturbed spot of earth. There is good evidence that moles are distasteful to some wild animals at least, if not to all, and they are seldom eaten by the domestic cats and dogs that have learned to catch them. Their peculiar rank odor may account for their not being relished. The dense, soft fur also may be objectionable to some animals.

Among birds of prey, hawks and owls take only a small toll from the mole tribe. Examination of the stomach contents of more than 2,000 of these birds disclosed the remains of only 13 moles. Five of these had been eaten by the red-tailed hawk, 4 by the red-shouldered hawk, and 1 each by the broad-winged hawk, the barred owl, the great gray owl, and the screech owl. Of 3,005 skulls of small mammals found in pellets disgorged by the barn owl, only 2 were of the mole.

Occasional or periodic floods that spread over lowlands adjoining streams constitute one of the greatest checks to the inordinate increase of moles. During these inundations large numbers of moles may be found congregating on elevated knolls and ridges or clinging to drift masses lodged against various obstructions. Even though these individuals survive, their young have probably perished, for it is in the breeding season that freshets are most common, and it is known that even heavy rains at this season drown some of the young in the nests.

CONTROL METHODS

Moles are comparatively difficult to control, but one who is patient, persevering, and somewhat skillful can catch or destroy them in a number of ways.

TRAPPING

Trapping is the most universally applicable and satisfactory method of mole control, but it is successful only if the habits and instincts of the mole are carefully considered. The suspicion of the mole, for instance, is aroused when its sensitive nose encounters anything foreign in its runway, and it will immediately back up and burrow around or under an ordinary trap set in its tunnel. It is not suspicious of dirt blocking the runway, however, as its burrow is frequently closed by farm machinery and by man and large animals stepping on it. The mole will immediately push its way into such a dirt blockade, reopen it, and continue on its way. This habit provides opportunity for using a specially designed trap that straddles, encircles, or is held suspended above the runway, the trigger pan resting on or hidden in a dirt blockade. Under such conditions the unsuspecting mole cannot detect the presence of the trap, and in pushing into the dirt obstruction it either lifts the trigger pan or pushes the dirt against the hidden trigger arm and thus releases the trap spring. If this general principle is understood by the trapper it will greatly simplify his efforts.

Another fundamental condition to be remembered is that the mole is most sensitive to an unnatural environment. For this reason the careful or experienced trapper never tears up large or numerous sections of the mole burrow in attempting to locate a favorable setting for a trap. The trapper should also bear in mind that a poorly set trap is a detour sign for the ever-suspicious mole.

The selection of a frequently used runway for a trap set is of prime importance. East of the Rocky Mountains most of the traps will have to be placed in the hunting tunnels, which are close to the surface and are indicated by the conspicuous ridges. It is to be remembered that these surface runways are made for the primary purpose of finding food. Many of them are therefore not used more than once; others, however, serve as highways and are used regularly. Ordinarily a runway that takes a more or less straight course for some distance, or seems to connect two systems of workings, will be in constant use. On the other hand, a tunnel that has mouse holes or breaks opening into it is not being used, as a mole invariably repairs any such surface openings. Thus the trapper can often determine the used tunnels by poking a small hole into all on the area and noting later, usually within a few hours, which ones have been closed. In large fields the runs in use may be found by driving a wagon or automobile back and forth across the area, flattening the mole ridges at intervals of 50 to 100 feet; the following day the regularly used runways will be raised again.

When the trapper can locate the deeper runs, which often are highways used by many individuals, he may catch a number of moles by continued use of traps in the same place. Such deeper tunnels are usually 3 to 12 inches or more below the surface, along fence lines or ridges in open fields, or at crossings from sodded to cultivated ground. Experiments have shown that in such cases an entire 6-acre field can be successfully treated by setting traps along the fence rows.

As moles are active throughout the year they may be trapped at any season, although it is not practical to carry on operations when the ground is frozen or exceedingly dry. The best time to trap is when fresh signs of mole activity are noted.

LOCATING RUNWAYS OF PACIFIC COAST MOLES

The larger moles of coastal Washington, Oregon, and California (*Scapanus*) differ in habits from the common moles east of the Rocky Mountains in that they push to the surface numerous piles of earth (mole hills) indicating the approximate location of their deeper burrows (fig. 5). This habit makes it feasible to trap them in the deeper, main-traveled tunnels.

In locating the runway a probe or slender metal rod, 3½ or 4 feet long and about ⅜ inch in diameter, such as an end-gate rod, or a piece of ¼-inch gas pipe may be used. This should be pushed into the soil 3 or 4 inches away from a selected mound (fig. 9). If directly over the runway, the trapper will feel a sudden give as the rod breaks into the tunnel opening. If this is not felt, the rod should be moved to either side and the probing process repeated at 2-inch intervals around the mound until a break is made through into the runway. Further probing at intervals of a foot or so from the mound will enable the trapper to determine the direction of the tunnel. Having thus definitely located the underground runway, he should excavate a trap hole and set the trap in the manner described on page 12.

MOLE TRAPS

Mole traps on the market are of two general types, the gripping and the harpoon. Gripping traps are of several designs, including the choker-loop trap (fig. 10), the scissors-jaw trap (fig. 11), and the diamond-jaw trap (fig. 12).

All are about equally effective. The harpoon trap (fig. 13) is more popular than traps of the gripper type because it is more easily set. It is somewhat less efficient, however, as the mole may escape if the prongs do not strike a vital spot.

In using the harpoon trap (fig. 13) the operator merely packs down the runway ridge with his foot and pushes the set trap (with safety catch in place) into the ground so that the trigger pan rests snugly on the depressed ridge and the two pointed supports straddle the runway evenly. The safety catch is then released, and the setting is complete. If the ground is hard or gravelly it is advisable to spring the trap once to make sure that the impaling spikes, or prongs, easily penetrate into the soil for their full length. If they do, the trap should be reset without changing its position; if not, a new place should be selected.

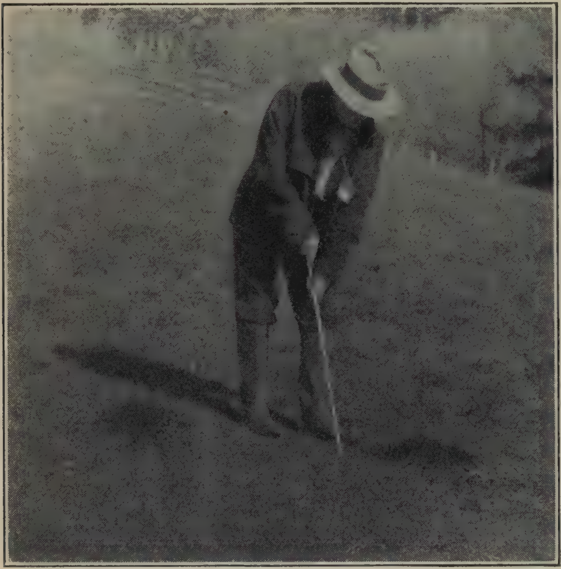
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FIGURE 9.—Locating deeper runway of Townsend's mole by probing around the mound with an iron rod.

To set a gripper trap (figs. 10, 11, and 12) it is usually necessary to make an excavation across the burrow and a little deeper than the burrow, just the width of the trap. A garden trowel is useful for this purpose. The exact direction of the tunnel is then noted from the opened ends, and the set trap is placed so that its jaws evenly straddle, or its loop encircles, this line or course. The excavated section is then blocked with loose, damp soil from which all gravel and rubbish have been removed. The soil is packed firmly underneath the trigger pan with the fingers and the trap settled so that the trigger rests snugly on the built-up soil; this step is omitted when the diamond-jaw trap (fig. 12) is used. Finally, the trap hole is filled with enough loose dirt to cover the trap level with the trigger pan and exclude all light from the mole burrow. If this is done carefully, the mole in forcing its way through the soil blockade will be certain to spring the trap—by raising the trigger pan (of the choker-loop or scissors-jaw trap) or by moving it to one side (if the diamond-jaw trap is used).

Choker-loop and diamond-jaw traps, both of the gripper type, may be successfully set in loose, mellow, damp soils without making an excavation, by following the method described for setting the harpoon trap.

OTHER METHODS

Caretakers of golf courses, cemeteries, and other large areas of lawn and garden frequently detect the movements of moles just below the surface and easily throw them out with a shovel or hoe. Some gardeners make a practice of opening runways each morning with the hope of later catching the moles in the act of repairing them. Where hose connections are available moles may be drowned out by flooding the runways, especially during April, when the young are most likely to be in the nest and cannot escape the water.

Gassing has been given increased attention in recent years, following the development of highly toxic and easily applied compounds. Calcium cyanide dust or carbon disulphide in a gaseous form pumped into the runway may destroy the moles under certain conditions or may cause them to avoid the gassed areas. Experiments, however, have indicated that this method is not dependable and that the cost is greater than the results justify.

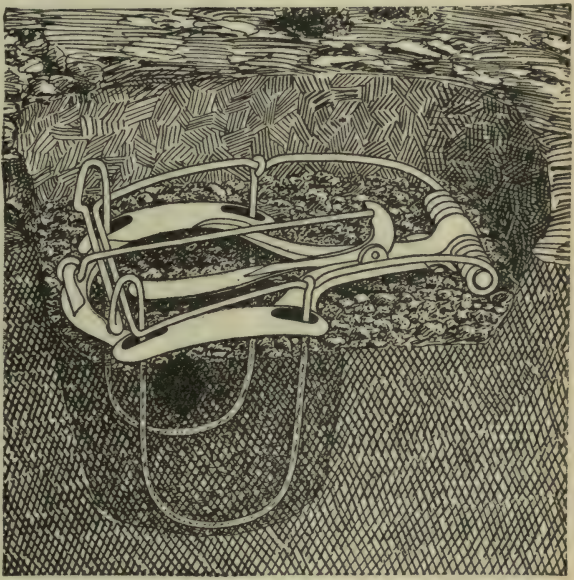

FIGURE 10.—A choker-loop trap, in position at one of the deeper runways of a mole's system of burrows. The loops must encircle the runway.

The marked tendency of the mole to avoid obnoxious or injurious substances often makes the use of repellents practical in small restricted areas of lawn or garden. Lye, paradichlorobenzene, and naphthalene seem most effective. The visible mole runways should be opened with the finger or a small stick, a teaspoonful of one of these materials inserted, and the opening carefully closed. Applications should be made at intervals of 8 or 10 feet along the raised runways and should be repeated whenever sections of old runways show signs of being in use or when any new ridges appear.

Fencing small areas with woven wire or with concrete is sometimes practicable where valuable plants require special protection against eastern moles. Galvanized hardware cloth with 3 meshes to the inch for excluding mice as well as moles will last a number of years, but concrete walls 1 inch or more thick have been found cheaper in the long run. Fencing alone, however, cannot always be depended upon, and it may be necessary to supplement this method of control by trapping.

In destroying most small animal pests, poisoning is usually the means most effectively employed, and many experiments have been conducted to learn whether poisons can be used also in mole control. Because, however, of the specialized, carnivorous food habits of moles and their highly developed instinct to avoid unfamiliar substances, no method of poisoning them can be recommended as generally satisfactory.

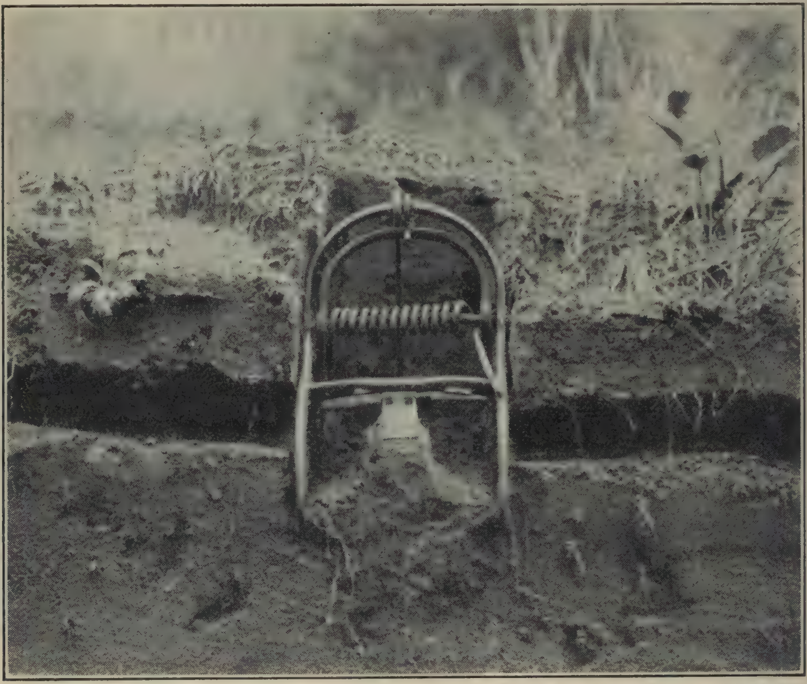
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FIGURE 11.—A scissors-jaw trap, set at the proper depth in relation to mole tunnel, the jaws straddling the burrow, a ridge of firmly packed soil in place under the trigger, and the set ready to be filled in with loose soil.

Pocket-gopher traps, gopher guns, snares, and other mechanical devices also are ordinarily impractical for use in controlling moles.

UTILIZING MOLESKINS

In England and Scotland and in some of the continental coast countries of Europe moles are trapped extensively for their pelts, and on certain estates for the private bounties paid for their extermination. This has hitherto been the sole source of supply of moleskins for use by manufacturing furriers in this country. The Bureau of Biological Survey has found, however, that, although the skins of the common mole of the eastern United States are somewhat inferior in quality to the imported product, pelts of certain other American moles may prove to be equal in value for the furrier's purposes to those of the European species (*Talpa europaea*). This applies particularly to the skins of Townsend's moles, which are certainly larger than those of Europe and appear to have texture and fur fully as good. They cannot, however, be handled and processed in the same lots with the latter, as they do not take dyes in the same way.

As a rule the farmer boy or the trapper who has accumulated a lot of moleskins will want to dispose of them as he would any other kind of pelt, by selling to a reliable fur dealer. If local furriers do not handle this class of skin and are not informed on current prices or methods of grading, it is well to write for lists or quotations to one of the larger establishments doing business by mail. The plan of pooling shipments of moleskins through farm-bureau organizations or county agricultural agents has been successfully practiced in some communities.

SKINNING MOLES

The process of skinning a mole is simple, and with a little practice one should be able to do the job in 5 minutes, including stretching the skin to dry. The skin envelops the animal loosely, showing considerable slack wherever handled. It is so tough, too, particularly on the larger species, that it will stand all the pulling necessary to remove it from any part of the body. Perhaps the best tool for the work is a small pair of strong scissors about 4 or 5 inches long, with one blunt-pointed and one sharp-pointed blade, though a sharp-pointed pocketknife may be used.

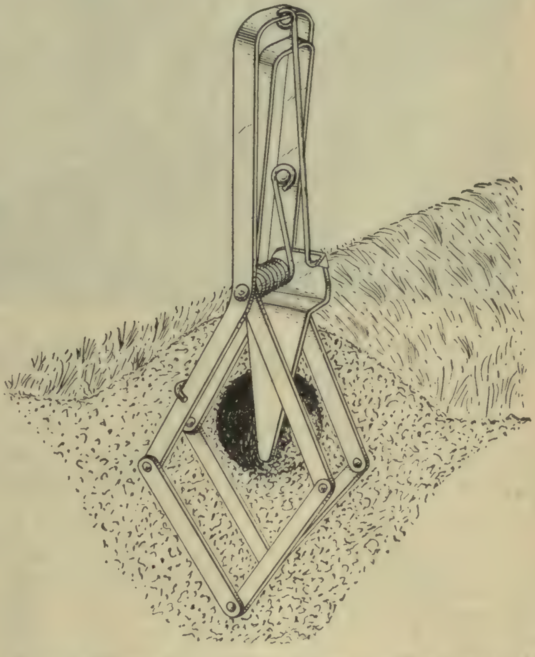

FIGURE 12.—A diamond-jaw trap, set. The runway is directly back of the trigger. Moving the trigger in any direction releases the spring.

Proceed as follows: With scissors or knife make a slit in the skin down the middle of the belly from chin to root of tail, loosening the pelt with the fingers as you proceed, to avoid cutting through into the abdominal cavity. Now husk the skin from the body, using the cutting tool only to sever the legs at the ankles, the tail at the root, and the arms at the wrists—all on the inside. After a little snipping at the connective tissue about neck and head, the skin can be pulled over the nose and off the body entirely.

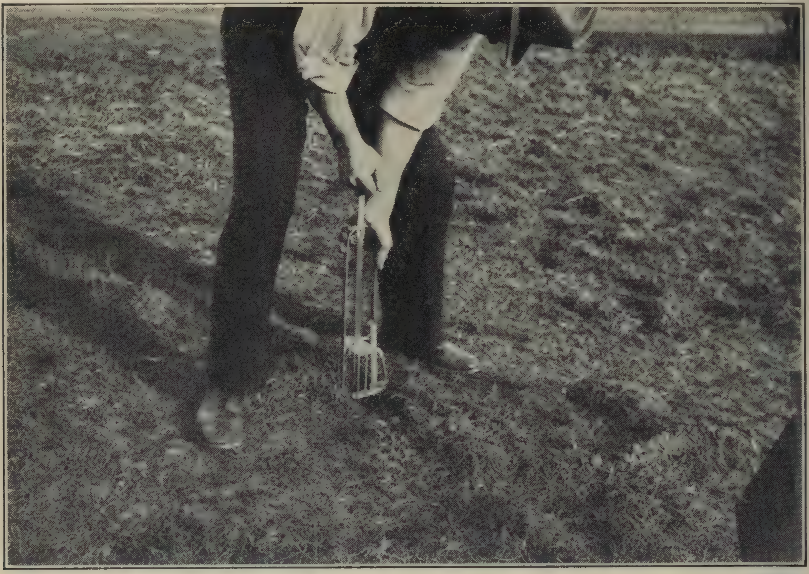

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FIGURE 13.—Setting the harpoon trap. Sharp prongs poised above the runway are released and forced downward when the mole raises the depressed soil under the trigger pan. (See also illustration on title page.)

When the skin is off, pick from it all bits of fat and snip off the legs and tail, without cutting the pelt proper. Stretch the skin on a board to dry, fur side down, using common pins to hold it in place;

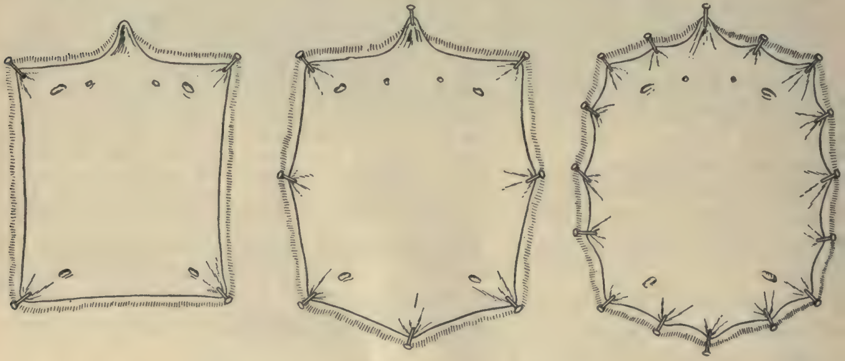

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FIGURE 14.—The three stages in drying a skin: (1) Four pins are first driven in, one in each corner; (2) four intermediate pins are then inserted, the skin being slightly stretched; (3) finally, eight more pins are tacked in, one between each two already in place.

they are strong enough and sharp and do not leave conspicuous holes in the pelt, as would tacks or nails. A light tack hammer will serve to drive the pins in, and a pair of forceps with corrugated tips will help in the stretching, though after a little experience one will only need to use the fingers (fig. 14).

Hang the drying boards where the air circulates freely, but not in the sunshine. In damp or rainy weather when skins are being dried indoors they should be placed as far as practicable from any stove or other source of heat. They will dry in a few days and, when stiff and parchmentlike, may be stored away indefinitely, though it is best not to hold them more than a few months to a year, as they may become brittle with age when not tanned. They need no treatment with preservatives of any sort, but must be kept in a cool, dry place safe from insects and mice.

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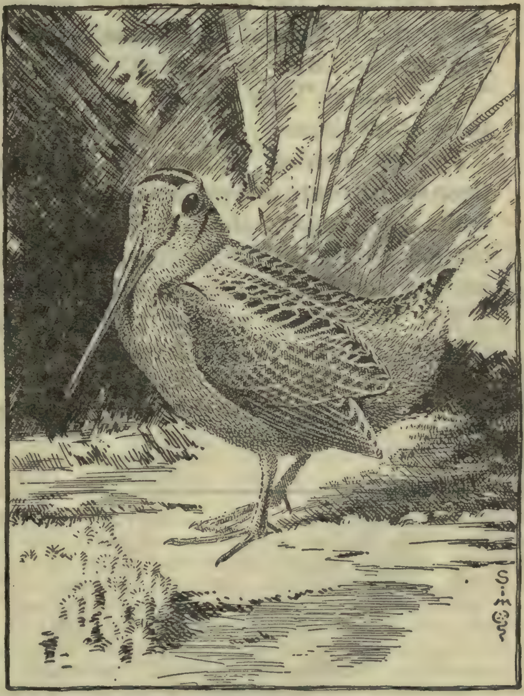
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1717

GAME LAWS

FOR THE SEASON 1933-34

A Summary of the Provisions of Federal, State, and Provincial Statutes



THE THIRTY-FOURTH annual summary by the Bureau of Biological Survey of Federal and other game laws and regulations is here presented to inform hunters, farmers, and others interested in wild life regarding the relation of restrictions on hunting to the future enjoyment of the sport and to aid Federal and State law-enforcement officials in the administration of the Migratory Bird Treaty and Lacey Acts and other laws for the conservation and restoration of game.

The provisions as set forth furnish a brief and convenient synopsis of the laws. Provisions relating to methods of capture, game refuges, enforcement of laws, disposition of fees and fines, and minor matters are omitted, as also are full texts of Federal and Canadian laws and regulations relating to birds and game. Species not listed under "open seasons" for States and Provinces are protected there at all times.

Persons desiring information regarding further restrictions set by State or Provincial law or regulation on seasons, limits, possession, and other hunting provisions should communicate with the appropriate officials, whose addresses are given on the last page of this bulletin.

The illustration on the title-page is of a woodcock (*Philohela minor*) from a drawing by R. J. Sim.

Washington, D.C. **Issued October 1933**

GAME LAWS FOR THE SEASON 1933-34

A SUMMARY OF FEDERAL, STATE, AND PROVINCIAL STATUTES

By H. P. SHELDON, *United States game conservation officer, in charge*, and FRANK G. GRIMES, *junior administrative assistant; Division of Game and Bird Conservation, Bureau of Biological Survey*

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INTRODUCTION

URGENT NEED FOR RESTRICTIONS ON HUNTING

TWO YEARS AGO, by Executive proclamation, the President called upon sportsmen, landowners, and all others interested in the future of waterfowl to lend their cooperation to effect full observance of the Federal regulations protecting migratory birds, in order that adequate numbers might return to their breeding grounds and that there might be "no repetition of the calamity of extermination that has already overtaken some species of our American birds." The menace caused by drought, drainage, and overshooting still faces the waterfowl.

In the existing emergency, sportsmen are again urged to practice, and encourage among others, strict moderation in shooting, and to see that the kill is made chiefly from the more abundant species, and that every practicable effort is made to spare the kinds that are seriously reduced and in danger of early extinction.

Reports of a large number of observers in the United States and in Canada transmitted to the Biological Survey by its representatives and by Canadian officials during the 1933 nesting season, when summarized, indicated that in the opinion of a majority of these observers there was no substantial improvement in waterfowl conditions over the preceding year, although there appeared to be a slightly larger hatch than in 1931 and 1932. Indications early in fall were that pintail, mallard, and black ducks might be expected in fair numbers in favorable concentration areas during migration, but that canvasbacks, redheads, scaups, blue-winged teal, and certain others would again be at an exceedingly low ebb. Geese, with the exception of brant on the Atlantic coast, were expected in about the same numbers as in recent years.

It is evident that united and continued effort must be made to maintain an adequate breeding stock of waterfowl and to build up the supply of several important species to a point where their hunting may be enjoyed without constant fear of their virtual extermination. This can be done by vigorous, concerted action and the exercise by sportsmen of an intelligently guided spirit of moderation. The era of unlimited, indiscriminate slaughter of waterfowl must be recognized as a period of exploitation of our natural resources that is definitely past.

The only hope for the future of migratory game birds and the sport of wildfowling is in measures that will considerably reduce the numbers of birds that will be killed, until such time as the breeding stock has been restored. There is no other way. In the present critical situation the value of refuge areas, for instance, is more to be measured by their effectiveness in reducing the kill of wild fowl than by the extent to which these areas may increase the nesting and feeding grounds. These latter benefits are of primary importance to the future of the birds but are secondary issues at this time, when the immediate problem is to conserve the existing breeding stocks.

The Biological Survey has never taken the position that restricting the kill alone would be a satisfactory method of perpetuating the various game species. It has urged the adoption of a program that would include the establishment of an extensive refuge system, control of losses by disease and by predatory creatures, and measures to increase wild fowl wherever possible by improving environmental conditions as rapidly as effective methods can be developed by research and as extensively as funds available will permit. Of all the methods, however, reducing the annual kill is the only one that can be immediately effective in overcoming the present shortage of birds.

It is of vital importance that these matters be known to every person who desires the perpetuation of the migratory game birds, and it is equally important that the American sportsmen should not be deceived in regard to the seriousness of the situation by optimistic reports of local abundance or led away from the obvious course by assurances that other easier methods can be found that will be equally effective. Such hopes are groundless. Whether sufficient birds can be saved from what remains of a once great inheritance to continue reasonable shooting privileges in 10, or 5, or even 3 years from now, depends most of all upon the willingness of the American sportsman to meet the crisis by a clear, intelligent recognition of the situation and to accept any restrictions that may be applied.

FEDERAL WILD-LIFE REFUGES

The Bureau of Biological Survey now administers 102 wild-life refuges, 2 new ones having been added during the present year. Most of these are within continental United States, though some are in Alaska, Hawaii, and Puerto Rico. Six have been established primarily as big-game preserves, 1 in Alaska for reindeer and caribou experiments, and 1 in Alaska for muskrats and beavers. The others are bird refuges, and all six of the big-game preserves also have been designated as bird refuges.

During the past year, intensive examinations, including valuation, of 141 desirable wild-life refuge areas, containing more than 3,700,000 acres of land and water, have been made by the Biological Survey, to determine types of land, uses to which put, ownership, and the character, extent, and value of existing improvements. As a result, 10 units aggregating 751,593 acres of public lands in Alaska, Arizona, California, Florida, Georgia, Montana, Nevada, Oklahoma, and Utah, have been reserved by Executive order as migratory-bird refuges. There have been withdrawn for classification, pending further investigations to determine their suitability for refuge purposes, 171,743 acres of land in Nevada, New Mexico, Oregon, and Washington. In addition, 43,264 acres of lands and waters have been added by Executive orders to units established or in the process of establishment in Florida, Nebraska, North Dakota, South Carolina, and Wyoming.

The Migratory Bird Conservation Commission has approved for lease and purchase 137,664 acres in 10 units in California, Florida, Maryland, Nebraska, Nevada, North Carolina, North Dakota, South Carolina, and Wyoming, of which 121,956 acres have been acquired. The total area thus far purchased under the refuge program and awaiting conveyance, acquired by Executive order, gift, act of Congress, cession by States, and lease aggregates 1,114,598 acres.

Under the emergency-conservation program, Civilian Conservation Corps camps have been established on three of the bird refuges, and extensive developments and improvements, including the construction of roads, trails, fire lines, look-out towers, fences, and dams for the creation of fresh-water ponds for the production of wild-life food, are going rapidly forward.

Under the public-works program, approximately $970,000 has been allotted, which will be devoted to extensive improvements in many of the Federal bird refuges and game preserves now administered by the Biological Survey and the purchase of necessary equipment for carrying on the work of better conserving the wild-life resources of the country.

REVIEW OF LEGISLATION OF 1933

FEDERAL SEASONS AND BAG LIMITS

Amendments of the Federal regulations under the Migratory Bird Treaty Act, approved by the President on September 11, 1933, provide approximately the same seasons for hunting migratory game birds as during 1932–33. The new regulations make the waterfowl seasons apply to Wilson's snipe or jacksnipe throughout the country and to rails and gallinules in Wisconsin and New York.

Because of the alarming shortage of eelgrass, the principal winter food of the brant on the Atlantic coast, the season on that species was closed throughout the Atlantic Coast States. For the first time since 1930, an open season has been provided for cackling geese.

Separate zones for hunting waterfowl were established for the northern and southern parts of three States—Idaho, Arizona, and New Mexico.

The dove season in Florida, in the counties lying west of the Ochlockonee River was changed to November 1–January 31, to conform to the season in the coastal counties of Alabama.

The closed season throughout the country was continued on wood ducks, ruddy ducks, bufflehead ducks, and swans, and on all shore birds except woodcock and jacksnipe.

One provision of the new regulations reduces the daily bag limit on ducks to 12, with the additional provision that not more than 8 of any one, or 8 in the aggregate, of canvasbacks, redheads, ringnecks, teal, shovelers, and gadwalls, may be taken in 1 day. The daily bag limits of 4 woodcock and of 4 geese (including brant in those States having an open season on brant), were continued in effect, as was also the possession limit of 8 geese (including brant), but the possession limit of woodcock was restricted to 12.

STATE AND PROVINCIAL LEGISLATION

Regular sessions of the legislatures were held in 44 States this year and a large number of laws affecting game and game-law administration were enacted, many of them of a purely local application.

ADMINISTRATIVE REORGANIZATIONS

In Florida, the department of game and fresh-water fish, and the offices of the State game commissioner, shell-fish commissioner, and State geologist were abolished by an act effective July 1, 1933, and their functions were vested in a State board of conservation, composed of the governor, the attorney general, the secretary of State, the State comptroller, the State treasurer, the commissioner of agriculture, and the superintendent of public instruction.

Under a referendum adopted in 1932 in the State of Washington, the system of county game commissions was abolished, and a State department of game, administered by a commission of six members, was created. The commission was vested with full power to appoint a director of game and to prescribe and change seasons, bag limits, and methods of taking game birds and animals.

In North Carolina an amendment to the conservation law provides that in counties not having game commissions created by legislative enactment, the commissions shall consist of the chairman of the board of county commissioners, the clerk of the superior court, and the bonded game warden of each county. The State was also divided into three hunting zones, eastern, central, and western. Another act of the North Carolina Legislature, effective July 1, 1933, abolished the offices of State game warden and commissioner of inland fisheries, and provided for the appointment of a person of scientific training and experience to perform the duties of these offices.

Oklahoma enacted a law, effective April 10, 1933, under which the Federal Government is authorized to make such rules and regulations as may be deemed necessary regarding game and nongame animals and birds, and fish in or on national-forest lands in the State.

FARMER-HUNTER RELATIONS

In Colorado and Oregon, laws were enacted modeled after the Nebraska law, providing for the issuance of hunters' scrip books. Persons desiring to hunt upland game birds on the lands of farmers who have entered into agreement with the State, present these scrip books to the farmer at the beginning of the day's shoot, and at the end of the day the farmer detaches one coupon for each pheasant or other upland game bird killed. These coupons are stamped with the value of each, and the coupons are redeemed by the State on presentation. Colorado redeems the coupons at face value, while Oregon deducts 10 percent for administration. The Colorado law applies only to pheasants, while that of Oregon applies to all upland game birds.

BAITING AND DECOYS

An act of the Minnesota Legislature makes it unlawful to hunt any migratory waterfowl, or to molest, harass, or worry waterfowl by discharging firearms or other noise-making devices within 300 yards of any area on which natural or prepared grains have been placed for the purpose of attracting these birds.

A regulation of the Iowa commission prohibits the baiting of any area with food for attracting game birds for the purpose of shooting them, and provides that the erection of blinds, or the placing of decoys, or the concealment of hunters adjacent to areas on which food for wild game has been placed as permitted by law shall be presumptive evidence of an intent to violate the regulation.

In Alberta a regulation was adopted prohibiting the use of live decoys in hunting waterfowl.

SEASONS

BIG-GAME ANIMALS

Deer.—California advanced the deer season 1 month in 3 districts, to open August 16. Massachusetts closed the season in 1 county, while Michigan opened the season in 7 counties in addition to those already having an open season. Mississippi closed the season for 3 years in 7 counties, and prescribed broken seasons in 3 counties. Texas closed the season in 21 additional counties, and West Virginia changed the season in those counties having an open season, from December 1–18 to November 2–11. Nevada extended the season 15 days, to close October 30. In Canada, Alberta opened the season on deer in the area south of the North Saskatchewan River, where it was formerly closed; and Nova Scotia shortened the season, making it October 10–31 instead of October 16–November 15.

Elk.—Colorado opened the season on elk from October 12 to 18 in 9 counties and parts of 2 others. New Mexico provided an open season, November 6–15, in a restricted area.

Moose.—Alberta protected moose south of the railway from Calgary to Banff; opened the moose season where formerly closed south of the North Saskatchewan River; and prohibited all big-game hunting south of the Saskatchewan River and east of the Canadian Pacific Railway from Edmonton to Calgary and McLeod. Two other Provinces shortened the moose season, in New Brunswick the season now being October 20–November 20, and in Nova Scotia the same as on deer—October 10–31 instead of October 16–November 15.

Antelope.—New Mexico provided an open season of 5 days, October 1–5, in two counties.

Bear.—Colorado and Mississippi declared bears game animals, and closed the season on them—the former until 1935, and the latter for 3 years. In North Carolina protection was removed from these animals in the eastern zone of the State.

SMALL GAME ANIMALS

Rabbit.—In Connecticut the season on rabbits was extended 15 days to close December 31. Nevada extended the rabbit season to close December 31 instead of November 10. In Pennsylvania a staggered season of 16 days between November 1 and November 30 was prescribed.

Squirrel.—The open season on squirrels in Nebraska was advanced 15 days, opening September 15 instead of October 1, while in Pennsylvania the same staggered season was made to apply to squirrels as to rabbits.

GAME BIRDS

Quail.—California extended the quail season 15 days, from December 16 to December 31. Massachusetts opened the season for 1 month (October 20–November 20) in one county that had been closed. New Jersey extended until 1938 the closed season on quail in 10 counties, and in Pennsylvania a staggered season of 16 days was prescribed, as on rabbits. Texas closed the season in five additional counties, and West Virginia extended the season, making it November 15–December 31 instead of November 1–30.

Wild turkey.—Pennsylvania closed the wild-turkey season in 2 counties in addition to the 15 in which it was already closed, and prescribed the staggered season of 16 days as for rabbits. Texas closed the season in 5 additional counties. In South Carolina complete protection was afforded hen turkeys.

Pheasant.—California provided a season of 6 days, from November 15 to 20, on male pheasants throughout the State, except in one district; and Vermont opened the season for 8 days in October. The 16-day staggered season was also applied in Pennsylvania. In North Carolina the season was closed throughout the State. Mississippi closed the season for 3 years.

Grouse, prairie chicken, and spruce partridge.—Illinois closed the season on prairie chickens until 1939. Maine extended the ruffed-grouse season from November 9 to November 15. In the Upper Peninsula of Michigan the season on ruffed grouse and prairie chickens was made October 1–12. New Jersey extended until 1935 the closed season on ruffed grouse in seven counties, and in North Carolina the season was closed throughout the State on this species. Ruffed grouse in Pennsylvania were included in the group on which the 16-day staggered season applies. In Canada, Alberta made the season October 1–15 on ruffed grouse, blue grouse, and spruce partridge north of the Canadian Pacific Railway and Red Deer River; Nova Scotia shortened the season on ruffed grouse from October 16–November 15 to the period October 15–31; Quebec prescribed September 1–December 15 as the season on sharp-tailed grouse; and Saskatchewan shortened the season on sharp-tailed and pinnated grouse 16 days, closing October 15.

Woodcock.—An open season for woodcock was prescribed in Wisconsin from September 30 to October 15, thus curtailing by 14 days the season permitted under Federal regulations.

Doves.—In Kentucky an act was passed prohibiting the killing of doves before 12 o'clock noon.

Rails.—Maryland extended the rail season 1 month, to close October 31 instead of September 30.

LICENSES

Alabama adopted a 1-week-trip hunting license for nonresidents, costing $5 and Louisiana provided for a 4-day license for nonresidents, to cost $5. In Maryland a 5-day hunting license for nonresidents, costing $5.50, was adopted, with the provision that a nonresident owning land in the State may procure for $1.50 a license to hunt in the county in which his land is situated.

Arizona reduced the nonresident hunting license fee from $35 to $25, and Louisiana from $50 to $15. Michigan reduced its nonresident deer and bear license from $50 to $25, and its nonresident small-game license from $10 to $5; the cost of the deer and bear license for residents was reduced from $2.50 to $2.25, and the small-game license from $1.75 to $1. In North Carolina the nonresident hunting license fee was reduced from $15.20 to $10.10, and the resident State-wide license fee from $3.25 to $2.10, while the fee for a resident county license was reduced from $1.25 to 60 cents.

New Mexico made provision for the issuance of special licenses or permits for the taking of antelope and elk in restricted areas in which short open seasons are provided on these species.

Alberta provided a separate nonresident license for elk, costing $50, and increased the nonresident game-bird license from $5 to $25. On Prince Edward Island the nonresident hunting license was increased from $5 to $20, but the $5.60 license is still issued to nonresident landowners. Quebec adopted a special caribou license, costing nonresidents $25, and residents $5, while Yukon adopted a general hunting license for nonresident British subjects costing $75. The resident big-game license in Alberta was increased from $1 to $2, and the resident bird license from $2.25 to $2.50.

BAG AND POSSESSION LIMITS

The limits on valley quail in California were reduced one third, to 10 a day and 20 a week. Colorado adopted a limit of 1 deer or 1 elk a season, so that a licensee taking either one may not take the other. In Iowa the limit on quail was reduced from 15 to 10 a day, and it was also provided that not more than 30 game birds may be possessed at any one time. The limit on rabbits in Iowa was fixed at 15, with not more than a 2-day limit in possession.

Kentucky increased the possession limit on quail from 12 to 24; Vermont prescribed a limit of 2 pheasants a day, 4 a season; and Washington reduced the daily bag limit on quail and Hungarian partridges from 10 to 5.

FEDERAL LAWS RELATING TO MIGRATORY BIRDS [1]

Migratory birds included in the terms of the convention between the United States and Great Britain for the protection of migratory birds, concluded August 16, 1916, are as follows:

1. *Migratory game birds:*

(*a*) Anatidae, or waterfowl, including brant, wild ducks, geese, and swans.

(*b*) Gruidae, or cranes, including little brown, sand-hill, and whooping cranes.

(*c*) Rallidae, or rails, including coot, gallinules, and sora and other rails.

(*d*) Limicolae, or shore birds, including avocets, curlews, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs.

(*e*) Columbidae, or pigeons, including doves and wild pigeons.

2. *Migratory insectivorous birds:* Cuckoos; flickers and other woodpeckers; nighthawks or bull bats and whippoorwills; swifts; humming birds; flycatchers; bobolinks, meadow larks, and orioles; grosbeaks; tanagers; martins and other swallows; waxwings; shrikes; vireos; warblers; pipits; catbirds and brown thrashers; wrens; brown creepers; nuthatches; chickadees and titmice; kinglets and gnat catchers; robins and other thrushes; and all other perching birds which feed entirely or chiefly on insects.

3. *Other migratory nongame birds:* Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters and terns.

FEDERAL REGULATIONS

Following are the provisions of the Federal regulations, with amendments of September 11, 1933, fixing the open seasons on migratory game birds. Seasons on some of these species are further shortened by the provisions of State laws or regulations (for dates during which a person may hunt migratory game birds without violating either Federal regulations or State laws, reference should be had to the open seasons shown under the heading of each State, beginning on page 11).

MEANS BY WHICH BIRDS MAY BE TAKEN

The migratory game birds specified in regulation 4 hereof may be taken during the open season with a gun only, not larger than no. 10 gage, fired from the shoulder, except as specifically permitted by regulations 7, 8, 9, and 10 hereof; they may be taken during the open season from the land and water, with the aid of a dog, the use of decoys, and from a blind or floating device, except that in the taking of wild ducks not more than twenty-five (25) live-duck decoys may be shot over, and in the taking of wild geese in California the use of live-goose decoys is not permitted; but nothing herein shall be deemed to permit the use of an automobile, airplane, power boat, sailboat, any boat under sail, any floating device towed by power boat or sailboat, or any sinkbox (battery), except that sinkboxes (batteries) may be used in the taking of migratory waterfowl in coastal sounds and bays (including Back Bay, Princess Anne County, State of Virginia) and other coastal waters; and nothing herein shall be deemed to permit the use of an airplane, or a power boat, sailboat, or other floating device for the purpose of concentrating, driving, rallying, or stirring up migratory waterfowl; and mourning doves shall not be taken at, on, over, or within 100 yards of any place, area, or environment whatever, whereat or whereon has been placed, scattered, or distributed any corn, wheat, or other grain, salt, or other food designed, intended, or effective to bait, lure, attract, or entice such doves.

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[1] The full text of the Migratory Bird Treaty Act and regulations and of other Federal laws affecting birds and game is contained in Service and Regulatory Announcement—B. S. No. 78, which may be obtained from the Department of Agriculture, Washington, D.C. Likewise the Canadian migratory-bird regulations may be obtained from the Commissioner, National Parks of Canada, Ottawa, Ontario.

OPEN SEASONS (REGULATION 4)

For the purpose of this regulation, each period of time herein prescribed as an open season shall be construed to include the first and last days thereof.

Waterfowl (except snow geese and brant in Florida and all States north thereof bordering on the Atlantic Ocean, Ross's goose, wood duck, ruddy duck, bufflehead duck, and swans), rails, coot, gallinules, woodcock, Wilson's snipe or jacksnipe, mourning doves, and band-tailed pigeons may be taken each day from half an hour before sunrise to sunset during the open seasons prescribed therefor in this regulation, except that the hour for the commencement of hunting waterfowl, rails, gallinules, coot, and Wilson's snipe on the opening day of the season shall be 12 o'clock noon, and they may be taken by the means and in the numbers permitted by regulations 3 and 5 hereof, respectively, and when so taken may be possessed in the numbers permitted by regulation 5 any day in any State, Territory, or District during the period constituting the open season where killed and for an additional period of 10 days next succeeding said open season, but no such bird shall be possessed in a State, Territory, or District at a time when such State, Territory, or District prohibits the possession thereof. Nothing herein shall be deemed to permit the taking of migratory birds on any refuge established under the Migratory Bird Conservation Act of February 18, 1929 (45 Stat. 1222–26), nor on any area of the United States set aside by any other law, proclamation, or Executive order for use as a wild-life refuge except insofar as may be permitted by the Secretary of Agriculture under existing law, nor on any area adjacent to any such refuge when such area is designated as a closed area under the Migratory Bird Treaty Act.

Waterfowl (*except snow geese and brant in Florida and all States north thereof bordering on the Atlantic Ocean, Ross's goose, wood duck, ruddy duck, bufflehead duck, and swans*), **Wilson's snipe or jacksnipe, and coot.**—The open seasons for waterfowl (except snow geese and brant in Florida and all States north thereof bordering on the Atlantic Ocean, Ross's goose, wood duck, ruddy duck, bufflehead duck, and swans), Wilson's snipe or jacksnipe, and coot shall be as follows:

In Maine, New Hampshire, Vermont, Ohio, Michigan, Minnesota, Iowa, Nebraska, South Dakota, Montana, Wyoming, Colorado, Nevada, and that portion of Arizona comprising the counties of Mohave, Yavapai, Coconino, Navajo, and Apache, October 1 to November 30;

In Massachusetts, Rhode Island, Connecticut, New York (except Long Island), Pennsylvania, West Virginia, Illinois, Missouri, Kansas, Oklahoma, Utah, Washington, Oregon, Idaho (except in the counties of Bonner, Boundary, Benewah, Kootenai, and Shoshone), and that portion of New Mexico lying north and west of a line beginning at the eastern boundary of the State where the Southern Pacific Railway crosses the State line, 4 miles northeast of Nara Visa, N.Mex., thence following the center of the main Southern Pacific Railway track through the towns of Tucumcari, Santa Rosa, Vaughn, Corona, and Carrizozo, to the town of Tularosa, N.Mex., where said track is crossed by State Highway No. 52; thence west following said Highway No. 52 to Elephant Butte Dam; thence following a line running west through the towns of Hot Springs and Hermosa to the northeast corner of Grant County; thence continuing due west along the north line of Grant County to the State boundary line, October 16 to December 15;

In Wisconsin, North Dakota, and that portion of Idaho comprising the counties of Bonner, Boundary, Benewah, Kootenai, and Shoshone, September 21 to November 20;

In that portion of New York known as Long Island, and in Delaware, Indiana, Kentucky, California, and that portion of Texas lying west and north of a line beginning on the Rio Grande River directly west of the town of Del Rio, Tex.; thence east to the town of Del Rio; thence easterly following the center of the main track of the Southern Pacific Railroad through the towns of Spofford, Uvalde, and Hondo; thence to the point where the Southern Pacific Railroad crosses the International & Great Northern Railroad at or near San Antonio; thence following the center of the track of said International & Great Northern Railroad in an easterly direction, to the point in the city of Austin, where it joins Congress Avenue, near the International & Great Northern Railroad depot; thence across Congress Avenue to the center of the main track of the Houston & Texas Central Railroad where said track joins said Congress Avenue, at or near the Houston & Texas Central Railroad depot; thence following the center line of the track of said Houston & Texas Central Railroad in an easterly direction through the towns of Elgin, Giddings, and Brenham, to the point where said railroad crosses the Brazos River; thence with the center of said Brazos River in a general northerly direction, to the point on said river where the Beaumont branch of the Gulf, Colorado & Santa Fe Railway crosses the same; thence with the center of the track of the said Gulf, Colorado & Santa Fe Railway in an easterly direction through the towns of Navasota, Montgomery, and Conroe, to the point at or near Cleveland, where said Gulf, Colorado & Santa Fe Railway crosses the Houston East & West Texas Railway; thence with the center of said Houston East & West Texas Railway track to the point in said line, where it strikes the Louisiana line, November 1 to December 31;

In New Jersey, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Tennessee, Mississippi, Arkansas, Louisiana, and Arizona (except in the counties of Mohave, Yavapai, Coconino, Navajo, and Apache), and in those portions of Texas and New Mexico lying south and east of the lines above described, November 16 to January 15;

In Florida, November 20 to January 15; and

In Alaska, September 1 to October 31.

Rails and gallinules (*except coot*).—The open season for sora and other rails and gallinules (except coot) shall be from September 1 to November 30, except as follows:

In Massachusetts, October 1 to December 15;

In Washington, October 1 to November 30;

In New York (except Long Island), October 16 to December 15;

In that portion of New York known as Long Island, November 1 to December 31;

In Wisconsin, September 21 to November 20;

In Louisiana, November 1 to January 31; and

In the District of Columbia, no open season.

Woodcock.—The open seasons for woodcock shall be as follows:

In that portion of New York lying north of the tracks of the main line of the New York Central Railroad extending from Buffalo to Albany and north of the tracks of the main line of the Boston & Albany Railroad extending from Albany to the Massachusetts State line, and in Maine, New Hampshire, Vermont, and North Dakota, October 1 to October 31;

In Wisconsin, September 23 to October 22.

In that portion of New York lying south of the line above described, including Long Island, and in New Jersey, Pennsylvania, Ohio, Indiana, Michigan, and Iowa, October 15 to November 14;

In Massachusetts, Rhode Island, and Connecticut, October 20 to November 19;

In Missouri, November 10 to December 10;

In Delaware, Maryland, Virginia, West Virginia, Kentucky, Arkansas, and Oklahoma, November 15 to December 15; and

In North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Louisiana, December 1 to December 31.

Doves.—The open seasons for mourning doves shall be as follows:

In Delaware, Maryland, Virginia, Tennessee, Kentucky, Illinois, Minnesota, Nebraska, Kansas, Missouri, Arkansas, Oklahoma, New Mexico, Utah, Arizona, California, Nevada, Idaho, and Oregon, September 1 to December 15.

In that portion of Texas lying west and north of a line described above under Waterfowl, September 1 to October 31;

In that portion of Texas lying south and east of the aforesaid line, October 1 to November 30;

In North Carolina, South Carolina, Georgia, Alabama (except in Mobile, Baldwin, and Washington Counties), Mississippi, and Louisiana, September 1 to September 30 and November 20 to January 31;

In that portion of Alabama comprising Mobile, Baldwin, and Washington Counties and in that portion of Florida comprising all counties west of the Ochlockonee River, November 1 to January 31;

In Florida (except in Dade, Monroe, and Broward Counties and all counties west of the Ochlockonee River), November 20 to January 31; and

In that portion of Florida comprising Dade, Monroe, and Broward Counties, September 16 to November 15.

Band-tailed pigeons.—The open seasons for band-tailed pigeons shall be as follows:

In California and Arizona, December 1 to December 15;
In New Mexico, November 1 to November 15; and
In Washington and Oregon, October 16 to October 30.

BAG AND POSSESSION LIMITS

A person may take in any one day during the open seasons prescribed therefor in regulation 4 not to exceed the following numbers of migratory game birds, which numbers shall include all birds taken by any other person who for hire accompanies or assists him in taking migratory birds; and in the case of ducks, geese, brant, woodcock, and band-tailed pigeons when so taken these may be possessed in the numbers specified as follows:

Ducks (*except wood duck, ruddy duck, and bufflehead duck*).—Twelve in the aggregate of all kinds, but not more than 5 eider ducks, and not more than 8 of any one, or 8 in the aggregate, of the following species—canvasback, redhead, greater scaup, lesser scaup, ringneck, blue-wing teal, green-wing teal, cinnamon teal, shoveler, and gadwall—may be taken in any one day; and any person at any one time may possess not more than 24 ducks in the aggregate of all kinds, but not more than 10 eider ducks and not more than 16 of any one, or 16 in the aggregate, of the following species—canvasback, redhead, greater scaup, lesser scaup, ringneck, blue-wing teal, green-wing teal, cinnamon teal, shoveler, and gadwall.

Geese and brant (*except snow geese and brant in Florida and all States north thereof bordering on the Atlantic Ocean, and Ross's goose*).—Four in the aggregate of all kinds, and any person at any one time may possess not more than eight geese and brant in the aggregate of all kinds.

Rails and gallinules (*except sora and coot*).—Twenty-five in the aggregate of all kinds, but not more than 15 of any one species.

Sora.—Twenty-five.

Coot.—Twenty-five.

Wilson's snipe, or jacksnipe.—Twenty.

Woodcock.—Four, and any person at any one time may possess not more than 12.

Doves (*mourning*).—Eighteen.

Band-tailed pigeons.—Ten, and any person at any one time may possess not more than 10.

Migratory game birds legally taken may be possessed in any State, Territory, or District during the open season where killed and for an additional period of 10 days next succeeding such open season.

The possession limits hereinbefore prescribed apply as well to ducks, geese, brant, woodcock, and band-tailed pigeons taken in Canada and other foreign countries and brought into the United States, as to those taken in the United States.

SHIPMENT AND TRANSPORTATION

Not more than 2 days' bag limit of migratory game birds, or 1 day's limit of band-tailed pigeons, or 3 days' limit of woodcock may be transported by one person in one calendar week out of the State where taken, or from Canada into the United States, and any such birds or parts thereof in transit during the open season may continue in transit such additional time, not exceeding 5 days, as may be necessary for delivery at destination; but no such birds or parts thereof may be transported from a State, Territory, or District contrary to the laws of the State, Territory, or District in which they were taken or from which they were shipped.

Migratory game birds for which an open season is prescribed by Federal regulations, legally taken in and exported from a foreign country, other than Canada, may be transported to and possessed in any State during the open season prescribed by Federal regulations for such State and for a period of 10 days immediately succeeding such open season, in the numbers not exceeding those permitted to be taken in 2 days or possessed at any one time, if such transportation and possession is not prohibited by the laws of the State into which transported or in which possessed.

SALE

The Federal law prohibits the sale of all migratory birds throughout the United States except birds taken for scientific or propagating purposes and waterfowl raised on farms or preserves under permit from the Secretary of Agriculture. Feathers of wild ducks and wild geese lawfully killed, and of such birds seized and condemned by Federal or State authorities, may be purchased and sold for use in the manufacture of fishing flies, pillows, and mattresses, but not for millinery or ornamental purposes.

ALASKAN EXCEPTIONS

In Alaska, Eskimos and Indians may take for the use of themselves and their immediate families, in any manner and at any time, and possess and transport auks, auklets, guillemots, murres, and puffins and their eggs for food and their skins for clothing.

PERMITS FOR PROPAGATION AND OTHER PURPOSES

Under appropriate permit from the Secretary of Agriculture, and when allowed by State law, migratory waterfowl may be captured for propagating purposes, and waterfowl bred in captivity may be killed and the carcasses sold and used for food purposes. Waterfowl captured and bred in captivity may also be sold alive for breeding and exhibition purposes to the holders of permits. Under appropriate permit all species of migratory birds (except whooping cranes, trumpeter swans, and Eskimo curlew) may be taken for scientific purposes, and all species may be taken for banding. The Secretary of Agriculture may also issue orders permitting the killing of migratory birds to prevent serious injury to agriculture or other interests.

FURTHER RESTRICTIONS BY STATES

The States may shorten the open seasons fixed by Federal regulations on migratory birds, reduce the bag limits, prohibit export, restrict the period during which migratory birds may be possessed in close season, or make other laws or regulations to give further protection to such birds, but may not lengthen the open season, increase the bag limit, permit sale, or otherwise lessen the protection afforded by Federal law.

SUMMARY OF LAWS RELATING TO SEASONS, LICENSES, LIMITS, POSSESSION, TRANSPORTATION, AND SALE

GENERAL INFORMATION

GAME LAWS AND INFORMATION

Persons are advised to obtain from State game commissioners the full text of game laws in States where hunting is contemplated. (See list on p. 40.) They should also obtain information from the Bureau of Biological Survey or State game departments regarding the existence of Federal and State game and bird refuges in areas in which they contemplate hunting, as the location of refuges and the restrictions regarding hunting thereon are not included in this bulletin.

OPEN SEASON DATES

The dates of open seasons for migratory game birds shown under the various States and Provinces are the times when these birds may be hunted without violating either State or Provincial laws or Federal or Canadian regulations.

In stating the open season the plan has been followed of including the first and last days thereof. The difficulty of attaining absolute accuracy in a statement of the seasons is great, but summaries have been submitted to the proper State or Provincial game officials for correction and approval, and the dates as stated are believed to be free from material errors.

REST DAYS

In some States certain days of the week constitute rest days, or close seasons during the period when hunting is permitted. Persons contemplating shooting trips should inform themselves of the provisions of State law in this respect.

STATE LAWS

ALABAMA

Open seasons:	*Dates inclusive*
Deer (male)	Nov. 1–Dec. 31.
Bear	Nov. 1–Feb. 28.
Squirrel (see exception)	Oct. 1–Dec. 31.
Exception: In Baldwin, Butler, Choctaw, Clarke, Conecuh, Covington, Callas, Crenshaw, Escambia, Lowndes, Mobile, Monroe, Montgomery, Washington, and Wilcox Counties	Nov. 1–Jan. 31.
Quail (partridge)	Nov. 20–Feb. 20.
Wild turkey gobbler	Nov. 1–Dec. 31, Mar. 1–Apr. 10.
Ruffed grouse, introduced pheasant	Nov. 15–Dec. 15.
Dove (see exception)	Sept. 1–Sept. 30, Nov. 20–Jan. 31.
Exception: In Mobile, Baldwin, and Washington Counties	Nov. 1–Jan. 31.
Woodcock	Dec. 1–Dec. 31.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot (mud hen), Wilson's snipe or jacksnipe	Nov. 16–Jan. 15.[2]
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident or alien, $25. Nonresident 1-week trip license, $5. Resident—State, $3; county, $1. Issued by probate judges.

Bag and possession limits: 1 buck a day or in possession, 5 a season; 1 turkey gobbler a day or in possession, 10 a season; 10 squirrels, 15 quail a day or in possession; 2 ruffed grouse, 2 introduced pheasants a day, 20 each a season; 12 ducks a day, but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall; 4 geese, including brant, a day; 25 sora, 25 coot, 25 in the aggregate of all rails and gallinules except sora and coot, but not more than 15 of any one species of rails and gallinules, 20 Wilson's snipe, 4 woodcock, 18 doves a day. Not more than one day's bag limit of game birds may be possessed at one time. Possession of migratory game birds permitted during first 10 days of close season; other game during first 5 days. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game prohibited, except nonresident licensee may take with him, openly, game he has lawfully killed, but not more than 2 days' bag limit of migratory game birds may be exported in one calendar week.

Miscellaneous: Doves may not be shot within 100 yards of any area that has been baited with corn, wheat, or other food.

ALASKA

Open seasons:[3]	*Dates inclusive*
Bull moose (except yearlings and calves)	Sept. 1–Dec. 31.
Caribou, south of Yukon River	Aug. 20–Dec. 31.
North of Yukon River	No close season.
Deer (male, with horns not less than 3 inches above skull), east of longitude 138° (southeastern Alaska)	Aug. 20–Nov. 15.
In rest of Territory	No open season.
Mountain sheep (rams), mountain goats (except kids)	Aug. 20–Dec. 31.
Bear (large brown and grizzly)	Sept. 1–June 20.[4]
Black bear, polar bear (fur animals)	No close season.
Grouse, ptarmigan	Sept. 1–Feb. 28.
Duck (except ruddy duck and bufflehead), goose (except Ross's goose), brant, Wilson's snipe or jacksnipe	Sept. 1–Oct. 31.

Hunting licenses: Nonresident citizen—general, $50; small game, $10; licenses issued by commissioners, wardens, and special agents. Resident, $2 (trapping license required for taking black bears, which are fur animals under the law; not required of native-born Indians, Eskimos, or half-breeds who have not exercised the right of franchise or severed their tribal relations). Alien, $100 (special license required to hunt or possess firearms); issued by commission.

Guide, $10 (issued only to resident citizens or resident native Indian or Eskimo); issued by commission.

Shipping licenses: Resident (export for mounting and return), $1 for each trophy; resident removing from Territory, $1 for each trophy; if otherwise, $5 for each animal, $1 for each bird. Issued by commission or collector of customs.

Bag and possession limits: Caribou, nonresident 2, resident 5, a season (except on Alaska Peninsula, resident 2, nonresident 1); mountain sheep, nonresident 2 (on Kenai Peninsula, 1), resident 3 a season, of which not more than 2 may be taken south of Arctic Circle; 1 moose, 3 deer, 2 mountain goats a season or in possession; 2 in all of large brown and grizzly bears a season or in possession (nonresident); no limit for resident except 2 only in certain areas where a season is prescribed for residents, and in southeastern Alaska. Game animals legally taken during open season may be possessed and transported within Territory by any person at any time. Fifteen grouse, 25 ptarmigan, but not more than 25 in all of grouse and ptarmigan a day; 12 ducks a day, but not more than 5 eiders, nor more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall; 4 geese, including brant, 20 Wilson's snipe a day. Migratory game birds legally taken may be possessed during open season and 10 days thereafter, but not more than 50 in all of such birds may be possessed at one time, of which not more than 2 days' limit may be ducks, and geese, including brant. Game animals, grouse, ptarmigan, hides, heads, and feet of game animals or articles made therefrom and skins and feathers of game birds legally taken during open season may be possessed and transported at any time within the Territory, and shed antlers of deer, moose, or caribou may be possessed and transported within or out of the Territory at any time without a license.

Interstate transportation: Nonresident citizen or nonresident alien licensee may export 1 moose, 3 deer, 2 caribou (1 from Alaska Peninsula), 2 mountain sheep (1 from Kenai Peninsula), 2 mountain goats, and 2 in all of large brown and grizzly bears killed by himself under license coupon and affidavit that he has not violated the game laws; that big-game animal or part thereof he desires to ship has not been purchased or sold and is not shipped for purpose of being sold; that he lawfully killed the animal and is owner of part thereof that he desires to ship, and if shipment contains caribou or parts thereof, whether animal was killed on Alaska Peninsula.

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[2] *Alabama:* Mondays and Tuesdays are rest days for ducks, geese, and coot in Mobile County and part of Baldwin County.

[3] *Alaska:* Certain areas on which all hunting, or the hunting of certain species, is prohibited, may be ascertained by consulting Alaska Game Commission Circular No. 11, Laws and Regulations Relating to Game, Land Fur-Bearing Animals, and Birds in Alaska, published by the Department of Agriculture, or by communicating with the Alaska Game Commission, Juneau, or the Department of Agriculture, Washington, D.C.

[4] Season on large brown and grizzly bears applies throughout Territory to nonresidents, and to residents in coastal regions described in the circular referred to in footnote 3.

A nonresident may possess and transport at any time within or out of Territory skins and feathers of game birds and articles manufactured from hides or hoofs of moose, caribou, deer, or goats legally taken.

Residents may export for mounting and return in any one year, but not for sale, heads or trophies of game animal legally acquired under shipping license (fee, $1 for each trophy).

A resident who is removing his residence from Territory may export trophies of game animals legally acquired by him under shipping license (fee, $1 for each trophy).

All shipments must be marked with names and addresses of consignor and consignee and number of each kind of game contained therein.

ARIZONA

Open seasons:	*Dates inclusive*
Deer (male with pronged horn), bear (adult), wild turkey (see exception)	Oct. 16–Nov. 15.
Exception: Black-tailed or mule deer, bear, turkey, south of Gila River	No open season.
Squirrel (except Kaibab squirrel in State, and Chiricahua and Arizona tree squirrels south of Gila River and Salt River base meridian, no open season)	Oct. 16–Nov. 15.
Quail (Gambel's, scaled) (see exception)	Nov. 1–Dec. 31.
Exception: In Apache and Navajo Counties	No open season.
White-winged dove	July 15–Aug. 31.
Mourning dove	Sept. 1–Dec. 15.
Band-tailed pigeon	Dec. 1–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's), brant, coot, Wilson's snipe or jacksnipe (see exception)	Nov. 16–Jan. 15.
Exception: Duck, goose, brant, coot, Wilson's snipe or jacksnipe, in Mohave, Yavapai, Coconino, Navajo, and Apache Counties	Oct. 1–Nov. 30.

Hunting licenses: Nonresident—game and fish, $25; small game and fish, $10; fishing, $3. Resident game and fish, $2.50. Alien—game and fish, $75; small game and fish, $30. Special license, alien applicant for citizenship, small game and fish, $10. Guide, $10.

Bag and possession limits: 1 deer, 1 bear, 6 squirrels, 2 turkeys a season; 15 quail a day or in possession; 12 ducks a day, but not more than 8 of any one or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall—15 in possession; 4 geese, including brant, a day or in possession; 15 in all of Wilson's snipe and coots a day or in possession; 15 white-winged doves, 15 mourning doves a day. One male deer, 2 wild turkeys, or 1 day's bag limit of other game lawfully taken may be possessed for 10 days after close of season. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Nonresident licensee may ship 1 day's bag limit of game a week under permit attached to license, and may procure additional license for additional shipment.

Miscellaneous: Doves may not be shot within 100 yards of any area that has been baited with corn, wheat, or other food.

ARKANSAS

Open seasons:	*Dates inclusive*
Deer (male, with horns plainly visible above skull), bear, turkey gobbler (gobbler also Apr. 1–Apr. 30)	Nov. 13–Nov. 18, Dec. 20–Jan. 1.
Squirrel	May 15–June 15, Oct. 1–Jan. 1.
Open seasons—Continued.	*Dates inclusive*
Pheasant, prairie chicken	Dec. 1–Dec. 15.
Quail or partridge (bobwhite)	Dec. 1–Jan. 31.
Dove	Sept. 1–Dec. 15.
Woodcock	Nov. 15–Dec. 15.
Duck (except wood duck, ruddy duck, bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Nov. 16–Jan. 15.
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $15; resident, $1.10. For dog in hunting, $1.50. Guide, $10.

County licenses: Chicot County—Nonresident of State, $50; resident of State, all game, $5.25; game except deer and turkey, $2.25. Desha County—nonresident of State, $50; resident of State, all game, $2.50; game except deer and turkey, $1.10; dog for deer or quail hunting, $1.

Bag and possession limits: 2 deer, 2 turkeys, a season; 8 squirrels, 3 pheasants, 3 prairie chickens, 12 quail, a day or in possession; 18 doves, 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, including brant, 4 woodcock, 12 Wilson's snipe, 15 in all of rails, coots, and gallinules, a day, Two days' limit of squirrels, quail, or ducks and 12 woodcock, may be possessed at one time except while in the field hunting or returning from a hunt of 1 day's duration. Possession of migratory game birds permitted during first 10 days of close season.

Interstate transportation: Export of all game prohibited; provided, a nonresident, under each of 3 tags attached to his license may ship out 1 day's limit of game; and he may carry out at one time not more than 1 day's limit, but not more than 2 days' limit (3 days' in the case of woodcock) may be removed from State in any one calendar week; specimen of game may be exported by any person under permit to be mounted, tanned, or made into wearing apparel.

Miscellaneous: The baiting of migratory game birds and the use of more than 12 decoys (alive or dead) in the taking of wild ducks, are prohibited.

CALIFORNIA

Open seasons:	*Dates inclusive*
Male deer (except spike bucks):	
In districts 1, 4¼, 23, 24, and 25	Sept. 16–Oct. 15.
In district 1½	Sept. 1–Oct. 15.
In district 1¾ (deer must have more than two branches to each antler)	Sept. 16–Oct. 15.
In districts 2, 2½, and 3	Aug. 1–Sept. 14.
In districts 2¾, 4, and 4¾	Aug. 16–Sept. 15.
Bear (black, brown)	Nov. 15–Feb. 28.
Cottontail and brush rabbits (see exception)	Nov. 15–Dec. 15.
Exception: Rabbits in district 4¾	No close season.
Quail (see exception)	Nov. 15–Dec. 31.
Exception: In district 1½	Nov. 1–Dec. 31.
Dove (see exception)	Sept. 1–Sept. 30.
Exception: In districts 4, 4½, 4¾	Sept. 1–Oct. 31.
Pheasant (male), (see exception)	Nov. 15–Nov. 20.
Exception: In district 2	No open season.
Band-tailed pigeon	Dec. 1–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot (mud hen) Wilson's snipe or jacksnipe	Nov. 1–Dec. 31.
Gallinule	Oct. 1–Nov. 30.

Hunting licenses: Nonresident, $10; alien, $25 (except those with first papers, $10). Resident, $2 (resident under 18, $1). Deer-tag license, $1. Commercial club: Citizen owner, $25; alien owner, $100; citizen operator, $5; alien operator, $25. Issued by commissioners and county clerks.

Bag and possession limits: 2 deer a season (except in district 1¾, 1 only); 15 rabbits a day, 30 a week; 10 mountain quail a day, 20 a week; 10 valley or desert quail a day, 20 a week; 20 Wilson's snipe a day, 50 a week; mourning doves, 15 a day, 30 a week; 10 band-tailed pigeons a day or in possession; 2 male pheasants a day or in possession. 12 ducks a day (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), but not more than 2 day's limit of waterfowl in possession at one time; 4 geese, including brant, a day, 8 in possession; 20 Wilson's snipe a day, 25 in possession; 25 coots (mud hen) a day or in possession; 15 gallinules a day or in possession. One day's bag limit of game lawfully taken may be possessed for 5 days after close of season, except that deer meat may be retained for 15 days after close of season. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game and shipments of same by parcel post, prohibited.

Miscellaneous: The use of live decoys in the taking of wild geese is not permitted.

COLORADO

Open seasons:	*Dates inclusive*
Deer (with 2 or more prongs to each horn)	Oct. 12–Oct. 15.
Bear	No open season.
Bull elk, in Grand, Routt, Gunnison, Jefferson, Eagle, Clear Creek, Gilpin, Boulder, Summit Counties, Garfield County north of Colorado River, and Pitkin County east of Roaring Fork River only	Oct. 12–Oct. 18.
Rabbit, hare	No close season.
Prairie chicken	Sept. 15–Oct. 1.
Ringneck pheasant (male), in Adams, Arapahoe, Boulder, Jefferson, Larimer, Morgan, and Weld Counties only	Dec. 1–Dec. 5.
Mountain and willow grouse	Oct. 12–Oct. 21.
Sage chickens	Aug. 15–Aug. 20.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or or jacksnipe	Oct. 1–Nov. 30.
Rails and gallinules, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident—big game, $25; small game, $5. Resident—big game, $5; small game and fish, $2. Guide, $5, in addition to hunting license. Issued by commissioner, county clerks, and other agents. Aliens not permitted to hunt.

Bag and possession limits: 1 deer or 1 elk a season, coupon required; 2 pheasants a day, 3 in possession; 8 prairie chickens a day or in possession; 8 in the aggregate of mountain and willow grouse and sage chickens a day or in possession; 12 ducks (but not more than 8 of any one, or in the aggregate of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall) a day, but not more than 2 days' limit in possession; 4 geese, including brant, 20 Wilson's snipe, 25 sora, and 15 in all of other rails, coots, and gallinules, a day or in possession. Possession permitted during first 5 days of close season; but commissioner may issue permit (fee $1) authorizing storage, possession, and use of game for 90 days after close of season and game taken outside of State and legally exported may be possessed at any time (except possession of migratory game birds limited to 10 days after close of season).

Interstate transportation: Export of all protected game is prohibited; provided, game in not exceeding the numbers allowed in possession, may be exported under permit from game commissioner (fee, 25 cents for each bird) if permit be attached and packages plainly marked so as to show nature of contents, but not more than two days' limit of migratory birds shall be exported in any one calendar week; edible portion of deer may be exported under $5 permit from the commissioner. Importer must obtain from State game and fish commissioner a certificate, fee $1, to import game.

CONNECTICUT

Open seasons:	*Dates inclusive*
Hare, rabbit (except European, Belgian, or German hare and jack rabbit, no close season)	Nov. 2–Dec. 31.
Gray squirrel	Oct. 20–Nov. 23.
Quail	Oct. 20–Nov. 23.
Partridge or ruffed grouse, Mongolian, Chinese, or English pheasant (male)	Oct. 20–Nov. 23.
Woodcock	Oct. 20–Nov. 19.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's and snow geese and brant), coot (mud hen), Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $10.35. Resident $3.35. Issued by city, town, or borough clerk, Aliens not permitted to hunt.

Bag and possession limits: 3 hares or rabbits a day, 30 a season; 5 squirrels a day, 30 a season; 2 ruffed grouse, 2 pheasant, a day, 15 each a season; quail, 3 a day, 10 a season; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall) a day; 4 geese a day; but not more than 2 days' limit of ducks and geese may be possessed at one time; 4 woodcock a day, 12 in possession; 20 Wilson's snipe, 25 coots, 25 sora, and 25 of other rails and gallinules a day, but not more than 15 of any one species of rails and gallinules a day. Possession of more than the daily bag limit of game (except ducks and geese) prima facie evidence of violation. Resident may possess for his own use, but not for sale, during first 10 days of close season, game lawfully taken.

Game taken outside of State and lawfully exported may be possessed at any time, but migratory game birds may be possessed only during first 10 days of close season.

Interstate transportation: Export of all protected game prohibited; provided, a licensee under permit may export game lawfully killed and possessed and tagged to show name, address, and license number of shipper, if not for sale; but not more than 2 days' limit of migratory birds may be exported in one calendar week. To import game, importer must obtain permit from superintendent of fisheries and game.

DELAWARE

Open seasons:	*Dates inclusive*
Rabbit, hare, quail, partridge	Nov. 15–Dec. 31.
Squirrel (gray)	Sept. 15–Nov. 1.
Squirrel (fox, black)	Nov. 15–Dec. 31.
Dove	Sept. 15–Nov. 1, Nov. 15–Dec. 15.
Woodcock	Nov. 15–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's and snow geese and brant), coot, Wilson's snipe or jacksnipe	Nov. 1–Dec. 31.
Rail and gallinule (not including coot)	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $15.50. Resident, game and fish, $1.10 (required outside of county of residence). Issued by commission.

Bag and possession limits: 6 in all of rabbits, hares, and squirrels a day; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall) a day; 4 geese; 20 Wilson's snipe, 4 woodcock, 12 coots, 12 sora, 12 in all of other rails and gallinules, a day, and not more than 12 birds of any other species a day. Possession of migratory game birds permitted during first 10 days of close season, but not more than 2 day's limit of ducks and geese and not more than 12 woodcock may be possessed at one time. Upland birds may be possessed during first 5 days of closed season.

Interstate transportation: Licensee may carry or ship openly, within or out of State, not more than 10 rabbits, 10 squirrels, 50 rails, and 20 birds of other species, a week, but not more than 2 days' bag limit of other migratory game birds may be shipped or carried out in any one calendar week.

Miscellaneous: Doves may not be shot within 100 yards of any area on which corn, wheat, or other food has been placed or scattered to attract them. Unlawful to hunt game animals or birds when snow is on the ground.

FLORIDA

Open seasons:[5]

	Dates inclusive
Deer (male) (see exception)	Nov. 20–Dec. 31.
Exception: In Sumter County	No open season.
Squirrel, wild turkey, quail (see exception)	Nov. 20–Feb. 15.
Exception: Wild turkey in Sumter County	No open season.
Dove (see exceptions)	Nov. 20–Jan. 31.
Exceptions: West of the Ochlockonee River	Nov. 1–Jan. 31.
In Dade, Monroe, and Broward Counties	Sept. 16–Nov. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's and snow geese and brant), coot, Wilson's snipe or jacksnipe	Nov. 20–Jan. 15.
Rail, other than coot and gallinule	Sept. 15–Nov. 30.
Gallinules	Nov. 20–Nov. 30.

Hunting licenses: Nonresident, $25.50. Resident, $8 (State); $3.25 (county other than county of residence); $1.25 (county of residence). Issued by county judge. License not required of residents of Madison and Suwannee Counties.

Bag and possession limits: 1 deer a day, 2 a season; 2 turkeys a day, 5 a season; 200 of any other species of game birds or animals a season; 15 squirrels, 15 quail, 18 doves a day; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall) a day; 4 geese, 15 Wilson's snipe, 20 coots, and 25 in all of rails and gallinules but not more than 15 of any one species of rails and gallinules (other than coot) a day. Game lawfully taken, may be possessed during open season and for 5 days thereafter, but not more than 2 days' bag limit may be possessed at one time.

Interstate transportation: Export of all protected game prohibited, except that nonresident licensee may export game lawfully taken by himself, but not to exceed 2 deer and 5 turkeys a season, nor more than 2 days' limit of other game during any one calendar week.

Miscellaneous: Game animals and birds may not be taken on any field or waters on which corn, wheat, or other grain or food has been deposited, doves may not be shot within 100 yards of such baited areas.

GEORGIA

Open seasons:

	Dates inclusive
Deer (males only) (see exception)	Nov. 15–Jan. 5.
Exception: In Catoosa, Chattooga, Dade, Dawson, Fannin, Gilmer, Gordon, Habersham, Lumpkin, Murray, Pickens, Rabun, Stephens, Towns, Union, Walker, White, Whitfield, Bartow, Floyd, Marion, Schley, Webster, Chattahoochee, Muscogee, and Stewart Counties	No open season.
Bear	Nov. 20–Feb. 1.
Rabbit	No close season.
Cat squirrel (see exception)	Oct. 1–Jan. 15.
Exception: In Catoosa, Chattooga, Dade, Dawson, Fannin, Gilmer, Gordon, Habersham, Lumpkin, Murray, Pickens, Rabun, Stephens, Towns, Union, Walker, White, and Whitfield Counties	Aug. 15–Jan. 15.
Opossum	Oct. 1–Feb. 1.
Quail, wild turkey	Nov. 20–Mar. 1.
Doves	Sept. 1–Sept. 30, Nov. 20–Jan. 31.
Woodcock	Dec. 1–Dec. 31.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's and snow geese and brant), coot, Wilson's snipe or jacksnipe	Nov. 16–Jan. 15.
Rail (marsh hen) and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $25 (State); $10 (county of issue). Resident, State, $3.25; county, $1 (good only in county of residence). Issued by commissioner, county warden, or county ordinary.

Bag and possession limits: 2 deer, 2 turkeys, a season; 15 squirrels a day; 20 quail a day, 40 a week, 40 in possession; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveller, and gadwall), 4 geese, 20 Wilson's snipe, 4 woodcock, 18 doves, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails and gallinules (other than sora), a day. Migratory game birds lawfully taken may be possessed first 10 days of close season, but not more than 2 days' limit of wild ducks and geese and not more than 12 woodcock may be possessed at any one time. Special permit required to possess other game birds and game animals during close season.

Interstate transportation: Export of all protected game prohibited; provided, nonresident licensee may take out in personal possession, game lawfully killed, but not more than 2 days' limit of migratory birds may be exported in any one calendar week.

Game taken outside of State and legally exported may be imported and possessed under a permit, in like manner as game taken in State. Permits issued by game and fish commissioner.

Miscellaneous: Doves may not be shot within 100 yards of, and other game birds may not be shot on, at, or near, any area on which grain or other food has been placed or scattered to attract them.

HAWAII

Open seasons:

	Dates inclusive
Deer	Apr. 1–Oct. 31.
Quail (except bobwhite) in Maui County	Nov. 1–Jan. 31.
In Hawaii County	Dec. 1–Jan. 31.
In Kauai County, and city and county of Honolulu [6]	No open season.
Pheasant (male) in Maui, Kauai, and Honolulu [6] Counties	Nov. 1–Jan. 31.
In Hawaii County	Dec. 1–Jan. 31.

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[5] *Florida.* In St. Johns County residents may hunt deer on Friday and Saturday from June 15 to Aug. 15. In Walton County, season is closed on turkeys until June 30, 1935, and season on all other game closed from Jan. 17 to Oct. 30 of each year. In Flagler County deer may be hunted only on Thursday and Friday of each week during June until June 30, 1938, and squirrel, quail, jacksnipe, and dove may be hunted only on Monday, Friday, and Saturday during open season. On Lakes Jackson and Iamonia in Leon County, and Miccosukee in Leon and Jefferson Counties, waterfowl may be hunted only on Monday, Wednesday, and Friday during open season. In Marion County all game except deer, turkey, and migratory game birds may be hunted November 20 to January 31, but no game may be hunted except on Monday, Wednesday, and Friday during open season. Killing of deer in Marion County must be reported to county judge, sheriff, or game warden, and certificate of such reporting obtained. Rails in State may be hunted only on salt marshes.

[6] *Hawaii:* Hunting prohibited in city and county of Honolulu except on Saturdays, Sundays, and legal Territorial holidays.

Open seasons—Continued.	*Dates inclusive*
Wild dove, wild pigeon in Honolulu [6] County	Sept. 1–Dec. 31.
In Hawaii County	July 1–Jan. 31.
In Maui and Kauai Counties	July 1–Dec. 31.

Hunting licenses: County licenses—Nonresident citizens or declarant alien: Game, $10. Resident citizen: Game, $5. Alien: Game, $25. Hunting and fishing licenses issued by county treasurer.

Bag and possession limits: *Hawaii County:* Cock pheasants, 5 a day, 25 a season, quail, 15 a day, 30 in 7 consecutive days; doves and pigeons, 20 a day, 50 in 7 consecutive days. *Honolulu County:* Cock pheasants, 3 a day; doves and pigeons, 20 a day. *Kauai County:* Cock pheasants, 3 a day; doves and pigeons, 15 a day. *Maui County:* Cock pheasants, 5 a day, 10 in 7 consecutive days; quail, 10 a day, 25 in 7 consecutive days; doves and pigeons, 15 a day, 45 in 7 consecutive days.

IDAHO

Open seasons:	*Dates inclusive*
Elk, in Clearwater and Idaho Counties	Oct. 5–Nov. 10.
In Clark, Fremont, Jefferson, Madison, and Teton Counties	Nov. 15–Dec. 1.
In rest of State	No open season.
Deer, in Ada, Blaine, Boise, Butte, Custer, Elmore, Gem, Lemhi, Owyhee, and Valley Counties, and in Idaho County south of Main Salmon and east of Little Salmon	Oct. 5–Nov. 5.
In Clearwater County, and remainder of Idaho County	Oct. 5–Nov. 10.
In Clark, Fremont, Jefferson, Madison, and Teton Counties	Nov. 15–Dec. 1.
In Benewah, Bonner, Boundary, Kootenai, Latah, Lewis, Nez Perce, and Shoshone Counties	Nov. 1–Nov. 30.
In Bannock, Bear Lake, Caribou, Franklin, and Oneida Counties	Oct. 20–Oct. 30.
In Adams and Washington Counties	Oct. 15–Nov. 15.
Mountain sheep (ram only, under special license), in Valley and Lemhi Counties only	Oct. 15–Oct. 25.
Mountain goat, in Adams, Blaine, Boise, Butte, Custer, Elmore, Lemhi, Valley, Idaho, and Clearwater Counties	Oct. 10–Oct. 20.
Bear (see exception)	No close season.
Exception: In Benewah, Bonner, Boundary, Clearwater, Kootenai, Latah, Lewis, Nez Perce, and Shoshone Counties	Sept. 1–May 31.
Ruffed grouse (native pheasant), blue grouse, in Adams, Bingham, Blaine, Boise, Bonneville, Camas, Cassia, Clark, Elmore, Fremont, Gem, Gooding, Jefferson, Jerome, Lemhi, Lincoln, Madison, Minidoka, Owyhee Teton, Twin Falls, Valley, and Washington Counties	Aug. 10–Aug. 25.
In Clearwater, Idaho, Nez Perce, Lewis, and Latah Counties (Wednesdays, Fridays, Sundays, and National holidays only)	Sept. 1–Sept. 30.
In Benewah, Bonner, Boundary, Kootenai, and Shoshone Counties	Oct. 1–Oct. 15.
In rest of State	No open season.
Open seasons—Continued.	*Dates inclusive*
Sharp-tailed grouse, in Blaine, Boise, Camas, Cassia, Elmore, Fremont, Gem, Gooding, Jerome, Lincoln, Minidoka, Owyhee, Twin Falls, and Valley Counties only	Aug. 10–Aug. 25.
Hungarian partridge, in Benewah, Bonner, Boundary, and Kootenai Counties	Nov. 1–Nov. 15.
In Clearwater, Idaho, Latah, Lewis, Nez Perce Counties (Wednesday, Friday, Sunday, and National holidays only)	Nov. 1–Nov. 30.
In Ada, Adams, Boise, Gem, Payette, and Washington Counties	Nov. 1–Nov. 15.
Sage hens, in Bannock, Bear Lake, Bingham, Blaine, Boise, Bonneville, Butte, Camas, Caribou, Cassia, Clark, Custer, Elmore, Franklin, Fremont, Gem, Gooding, Jefferson, Jerome, Lemhi, Madison, Minidoka, Oneida, Owyhee, Power, Teton, Twin Falls, and Valley Counties	Aug. 10–Aug. 25.
In Lincoln County	Aug. 1–Aug. 10.
Quail, in Ada, Canyon, Elmore, Gem, Payette, Washington, and Twin Falls Counties	Nov. 1–Nov. 10.
In Nez Perce County (Sundays, Wednesdays, Fridays, and National holidays only)	Nov. 1–Nov. 30.
Pheasant (Chinese, ringneck, mutant, and Mongolian), in Ada, Adams, Blaine, Canyon, Cassia, Elmore, Gem, Gooding, Jerome, Lincoln, Minidoka, Owyhee, Payette, Twin Falls, and Washington Counties	Oct. 15–Nov. 15.
In Bannock, Bingham, Bonneville, Jefferson, Lemhi, Madison, and Power Counties north and west of Snake River	Nov. 1–Nov. 10.
In Clearwater, Idaho, Latah, and Nez Perce Counties (Sundays, Wednesdays, Fridays, and National holidays only)	Nov. 1–Nov. 30.
Doves	Sept. 1–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe (see exception)	Oct. 16–Dec. 15.
Exception: In Bonner, Boundary, Benewah, Kootenai, and Shoshone Counties	Sept. 21–Nov. 20.
Rails and gallinules, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, game and fish, $50; bird only, $10. Alien, game and fish, $75; gun license, $5. Resident, $2. Special license for male mountain sheep in Valley and Lemhi Counties—nonresident, $50; resident, $25. Issued by warden, deputy, or authorized agent. Hunting license not required of Civil War veteran; children under 12 not permitted to hunt with firearms.

Bag and possession limits: 1 deer, 1 elk, 1 mountain goat, 1 mountain sheep, a season; 6 quail, 4 pheasants, 8 Hungarian partridge, 4 sage hens, native pheasant, or grouse, a day or in posssion; 12 ducks (but not more than 8 or any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, including brant, a day or in possession; 18 doves, 20 Wilson's snipe, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails and gallinules (other than sora), a day. Under affidavit and storage permit, migratory game birds may be retained in possession 10 days after close of season;

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[6] *Hawaii:* Hunting prohibited in city and county of Honolulu except on Saturdays, Sundays, and legal Territorial holidays.

other game may be possessed 5 days after close of season.

Interstate transportation: Export of all protected game prohibited, provided a hunter may export under hunting-license coupon, big game lawfully taken; and 1 day's limit of game birds may be transported in personal possession but may not be shipped or mailed. Big game once shipped within State may be exported under a 50-cent permit obtained from game warden or deputy. Mounted heads and stuffed birds legally obtained may be exported under a reshipping permit. Shipment of game by parcel post prohibited.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State, if identification tags or shipping or possession permits are attached.

Miscellaneous: Doves may not be shot within 100 yards of any area on which grain or other food has been placed or scattered to attract them.

ILLINOIS

Open seasons:	*Dates inclusive*
Rabbit	Nov. 10–Jan. 31.
Squirrel, in northern zone	Sept. 1–Dec. 1.
In central zone	Aug. 1–Dec. 1.
In southern zone	July 15–Dec. 1.
Quail (bobwhite)	Nov. 10–Dec. 10.
Introduced pheasant (cocks)	Nov. 10–Nov. 15.
Dove	Sept. 1–Sept. 30.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $15.50; resident, $1. Issued by village, county, or city clerk. Hunting club, $10; issued by department of conservation.

Bag and possession limits: 10 squirrels, 15 rabbits, 12 quail, 3 prairie chickens, 2 cock pheasants, 15 doves, 15 snipe, 15 in all of coots and gallinules, 15 rails but not more than 25 in all of rails, coots, and gallinules; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, including brant, a day. Limit, in possession, 20 squirrels, 36 quail, 9 prairie chickens, 6 cock pheasants, 25 doves, 50 snipe, 60 coots and gallinules, 60 rails, 24 ducks (but not more than 16 of any one, or in the aggregate, of the species above named), 8 geese, including brant.

Interstate transportation: Export of all protected game (except rabbit) prohibited; provided, nonresident licensee may take from State 50 game birds or animals, if carried openly for inspection, but not more than 2 days' limit of migratory birds may be exported in any one calendar week. Resident may carry out game under his license.

Deer lawfully killed and shipped may be brought or shipped into State, and rabbits may be imported November 10 to February 5.

Miscellaneous: Doves may not be shot within 100 yards of any area on which grain or other food has been placed or scattered to attract them.

INDIANA

Open seasons:	*Dates inclusive*
Rabbit	Nov. 11–Jan. 10.
Squirrel (except red squirrel, no close season)	Aug. 1–Oct. 14.
Quail, ruffed grouse	Nov. 10–Dec. 20.
Prairie chicken	Oct. 15–Oct. 31.
Woodcock	Oct. 15–Nov. 14.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Nov. 1–Dec. 31.
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $15.50; resident, $1. Issued by circuit clerks, superintendent of fisheries and game and his agents.

Bag and possession limits: 10 rabbits, 5 squirrels (no limit on red squirrels), 15 quail, 5 prairie chickens, 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, including brant, a day; 20 Wilson's snipe, 4 woodcock, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, a day. Not more than 12 woodcock, 2 days' limit of ducks and geese, including brant and 3 days' limit of other migratory game birds, may be possessed at one time. Possession of migratory game birds permitted during first 10 days of close season.

Deer, turkeys, and rabbits taken outside of State and legally exported may be possessed at any time; other game legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of deer, quail, grouse, prairie chicken, pheasant, wild turkey, and migratory game birds prohibited, except any licensee may export 15 game birds in the aggregate of all kinds, lawfully taken by himself, each day he hunts in State, but not more than daily limit of any one species, and not more than 2 days' limit of migratory game birds in any one calendar week, if carried openly for inspection together with his license or if the package is tagged or clearly labeled with names and addresses of shipper and consignee and an accurate statement of number and kind of birds.

IOWA

Open seasons:[7]	*Dates inclusive*
Squirrel	Sept. 1–Nov. 1.
Rabbit	Sept. 15–Feb. 1.
Woodcock	Oct. 15–Nov. 14.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 1–Nov. 30.
Rail and gallinule, other than coot	Sept. 16–Nov. 30.

Hunting licenses: Nonresident or alien, $15; resident, $1. Issued by county recorder and authorized agents.

Bag and possession limits: 10 squirrels, 15 rabbits a day; 2 days' limit, but not more than 30 in the aggregate, in possession. 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, including brant, a day; 15 Wilson's snipe, 4 woodcock, 15 each of rails, coot, and gallinules a day, but not more than 15 in all of rails and gallinules a day; 30 in the aggregate of game birds in possession, but not more than 2 days' limit of ducks, 8 geese including brant, 12 woodcock, and 15 each of other species in possession at one time.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during the open season and for 10 days immediately thereafter.

Interstate transportation: Export of all protected game prohibited, except that nonresident may take from State 15 game birds and animals lawfully killed, if open to inspection, and hunting license be shown on request, but not more than 2 days' bag limit of migratory game birds may be exported in any one calendar week.

Miscellaneous: Regulations of the commission prohibit the baiting of any area with food for the purpose of attracting game birds.

KANSAS

Open seasons:	*Dates inclusive*
Quail	Nov. 20–Nov. 30.
Prairie chicken (2 days)	Oct. 17–18.
Dove	Sept. 1–Oct. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose, (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.
Rails, other than coot and gallinule	Sept. 1–Nov. 30.
Gallinule	Oct. 1–Nov. 30.

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[7] *Iowa:* Seasons on upland game birds fixed by State fish and game commission.

Hunting licenses: Nonresident, $7; resident, $1 (county of residence and adjoining counties), $3 (state-wide). Issued by county clerk.

Bag and possession limits: 10 quail a day, 25 a season; 5 prairie chickens a day, 10 a season; 15 in all of ducks, Wilson's snipe, coots, and gallinules, a day, but not more than 12 ducks (8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall); 18 doves, 4 in all of geese and brant, 6 rails, a day. Possession of 2 days limit of 2 kinds of game permitted during first 5 days of close season, but not more than 2 days limit of wild ducks and wild geese including brant may be possessed at any one time.

Interstate transportation: Export of all protected game birds prohibited, except that a person under hunting license and affidavit of lawful killing and possession may ship to himself not more than 2 days' limit of two kinds of game taken by himself. Game of not more than 2 kinds, and not more than 2 days bag limit, taken outside of State and legally exported may be possessed during open season and first 5 days of close season.

Miscellaneous: Doves may not be shot within 100 yards of any area on which grain or other food has been placed or scattered to attract them.

Unlawful to shoot game birds while they are on the ground or water, unless wounded.

KENTUCKY

Open seasons:	*Dates inclusive*
Rabbit	Nov. 15–Dec. 31.
Squirrel	Aug. 1–Nov. 30.
Introduced pheasant (male)	Nov. 15–Nov. 19.
Quail, ruffed grouse (native pheasant)	Nov. 15–Dec. 31.
Dove	Sept. 1–Dec. 15.
Woodcock	Nov. 15–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Nov. 1–Dec. 31.
Rail and gallinule, other than coot	Sept. 14–Nov. 30.

Hunting licenses: Nonresident or alien, $10.50; resident, $1. Issued by county clerk.

Bag and possession limits: 12 squirrels a day, 24 in possession; 12 quail a day, 24 in possession, 75 a season; 15 doves a day, 15 in possession for each successive day of hunt; 2 ruffed grouse, 2 pheasant, 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall); 4 geese including brant; 4 woodcock; 20 Wilson's snipe, and 25 in all of rails, coots, and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Not more than 2 days' bag limit of wild ducks and wild geese and not more than 12 woodcock may be possessed at one time. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of deer, elk, and all game birds prohibited, except that a hunter may transport game lawfully killed and possessed by him, but not more than 2 days' limit of migratory birds may be exported in any 1 calendar week.

Miscellaneous: Doves may not be shot before 12 o'clock, noon, nor within 100 yards of any area on which grain or other food has been placed or scattered to attract them.

LOUISIANA

Open seasons:	*Dates inclusive*
Deer (male), bear, squirrel, chipmunk	Nov. 15–Feb. 15.
Hare, rabbit	Nov. 1–Feb. 15.
Quail	Nov. 15–Feb. 15.
Wild turkey	No open season.
Woodcock	Dec. 1–Dec. 31.
Dove	Dec. 1–Jan. 31.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Nov. 16–Jan. 15.
Rail and gallinule, other than coot	Nov. 15–Jan. 31.

Hunting licenses: Nonresident $15; nonresident 4-day license, $5. Resident, $1. Club or association, $5. Alien, general, $50; game birds, $25. Issued by tax collectors.

Bag and possession limits: 1 deer, 1 bear a day, 5 each a season; 10 squirrels and chipmunks combined a day, 120 a season; 15 quail a day, 120 a season; 18 doves a day, 300 a season; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall) a day, 300 a season; 4 geese, including brant, a day; 25 coot, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails, other than sora, and gallinules, a day; 4 woodcock a day, 22 a season, 12 in possession. Game in excess of 1 days' limit must be tagged, but not more than 2 days' limit of wild ducks and geese, including brant, may be possessed at one time. Possession of game birds permitted during first 10 days of close season.

Game taken outside of State and legally exported may be possessed at any time, except migratory game birds as above stated.

Interstate transportation: Export of all protected game prohibited; provided a nonresident licensee may carry with him out of the State under his license and tag 2 days' limit of game birds, if not for sale. All game and all packages containing game must be tagged to show kind and number, names of consignor and consignee, initial point of billing, and destination.

Miscellaneous: Doves may not be shot within 100 yards of any area on which grain or other food has been placed or scattered to attract them.

MAINE

Open seasons:	*Dates inclusive*
Deer, in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties	Nov. 1–Nov. 30.
In Aroostook, Penobscot, Somerset, Piscataquis, Franklin, and Oxford Counties	Oct. 16–Nov. 30.
In Hancock and Washington Counties	Nov. 1–Dec. 15.
Bear	Oct. 1–Nov. 30.
Hare, rabbit (see exception)	Oct. 1–Feb. 28.
Exception: In Franklin County	Oct. 1–Mar. 31.
Gray squirrel	Oct. 1–Oct. 31.
Ruffed grouse or partridge	Oct. 1–Nov. 15.
Woodcock	Oct. 1–Oct. 31.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's and snow geese, and brant), coot, Wilson's snipe or jacksnipe	Oct. 1–Nov. 30.
Rails and gallinules, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident or alien, big game, $15.15; small game, $5.15. Resident, hunting and fishing, $1.15; hunting, 65 cents. Issued by city, town, and plantation clerks. Guide license: Nonresident, $20; resident, $1. Sporting camp, $5. Shipping license (within State): Resident, deer, $2; 1 pair of game birds in 7 days, 50 cents; issued by commissioner.

Bag and possession limits: 1 deer a season; 4 ruffed grouse a day, 25 a season; 12 ducks (but not more than 5 eider ducks, nor more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, 20 Wilson's snipe, 4 woodcock, 25 coots, 25 sora, and 25 in all of other rails but not more than 15 of any one species of rails (other than sora) and gallinules, a day. Not more than 2 days' bag limit of wild ducks, and wild geese, and not more than 12 woodcock may be possessed at any one time. Deer may not be possessed in lumber camps, and must be transported open to view, tagged and labeled with name and address of, and accompanied by, owner. Possession of migratory game birds limited to first 10 days of close season.

Interstate transportation: Export of all protected game prohibited; provided, a resident of the State, under transportation tag (fee, $5) may take with him out of State game birds lawfully killed by himself. A nonresident licensee may take out, open to view, hares lawfully taken by himself, 1 deer, 4 partridges, 2 days' bag limit of ducks, geese, woodcock, and snipe, under hunting-license tags, when such tage bear written approval of a warden, deputy or the commissioner. Nonresident licensee may also ship out 1 pair of game birds a month under a special 50-cent license.

Moose or caribou, or parts thereof, taken outside of State and legally exported may be imported under license of commissioner for consumption or mounting, but not for sale. Deer properly tagged where taken and game birds may be imported under permit of commissioner and possessed in like manner as game killed in State. Permits and shipping tags issued by commissioner of inland fisheries and game.

Miscellaneous: Not more than 12 live decoys may be used by one boat or blind in hunting migratory waterfowl.

MARYLAND

Open seasons:	*Dates inclusive*
Deer (male, with 2 or more points to one antler), in Allegany County	Dec. 1–Dec. 10.
In Garrett County	Dec. 1–Dec. 5.
In Washington County, in game reserves enclosed with 7-foot fence	Dec. 1–Dec. 15.
In rest of State	No open season.
Rabbit or hare, quail (partridge), ruffed grouse, wild turkey, and English or ring-necked, Mongolian, and black pheasant (males only)	Nov. 15–Dec. 31.
Squirrel (see exception)	Sept. 15–Oct. 15, Nov. 15–Dec. 31.
Exception: In Garrett County	Oct. 1–Oct. 31.
Raccoon, opossum	Nov. 1–Jan. 31.
Dove	Sept. 1–Sept. 30, Nov. 15–Dec. 15.
Woodcock	Nov. 15–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's and snow geese and brant), coot, Wilson's snipe or jacksnipe	Nov. 16–Jan. 15.[8]
Rails and gallinules, other than coot	Sept. 1–Oct. 31.

Hunting licenses: Nonresident, $15.50 ($5.50 for State license if applicant owns real estate in Maryland assessed at $500; $1.50 for county license in county where such real estate is located). Nonresident, 5-day license, $5.50; resident: State, $5.25; county, $1.25. Issued by circuit-court clerks (in Baltimore City by clerk of court of common pleas). Booby, brush, or stake blind, $5.50 (not issued except to resident of State, or nonresident owner of land bordering on Potomac River, or nonresident owner of land bordering on any waters of the State and assessed at $500); pushers, $2.50. Issued by circuit-court clerks. *Susquehanna Flats:* Sinkbox, $20.75; sneakboat, $5.75.

Bag and possession limits: 1 deer a season; 1 turkey a day, 4 a season; 2 in all of English or Mongolian pheasants and ruffed grouse a day, 6 a season; 6 rabbits or hares, 10 squirrels, 10 quail (partridge), 4 woodcock, 18 doves, 20 jacksnipe, 25 coots, 25 in all of rails and gallinules, but not more than 15 of any one species of rails (except sora) and gallinules, a day; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), and 4 geese a day. Not more than 2 days' bag limit of ducks and geese and 3 days' limit of woodcock may be possessed at one time. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game (except waterfowl) prohibited; provided, a licensed hunter may take out under his license as personal baggage a quantity equal to two days' bag limit of game; provided further, no person may take or ship out more than two days' bag limit of ducks and geese in any one calendar week. Waterfowl must be shipped open to view and tagged.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

MASSACHUSETTS

Open seasons:	*Dates inclusive*
Deer (see exception)	Dec. 4–Dec. 9.
Exception: In Barnstable and Nantucket Counties	No open season.
Hare, rabbit (see exception)	Oct. 20–Feb. 15.
Exception: In Nantucket County	Oct. 20–Feb. 28.
Gray squirrel, quail, male pheasant, ruffed grouse (see exceptions)	Oct. 20–Nov. 20.
Exceptions: Quail, in Berkshire, Essex, Franklin, Hampden, Hampshire, Middlesex, Nantucket, and Worcester Counties	No open season.
Pheasant, in Dukes County	No open season.
Woodcock	Oct. 20–Nov. 19.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's, and snow geese and brant), coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.
Rail and gallinule, other than coot	Oct. 1–Dec. 15.

Hunting licenses: Nonresident citizen: Sporting, $15.25; hunting, $10.25. Nonresident who owns real estate in State assessed at not less than $1,000 or is a member of a hunting club assessed at not less than $1,000 for each member, same fee as resident. Resident citizen: Sporting, $3.25; hunting, $2. Permanent gunning stand or blind, $2.75. Issued by director of fisheries and game, department of conservation, city and town clerks.

Bag and possession limits: 1 deer a season; 2 hares, 5 rabbits, a day or in possession; 5 gray squirrels a day, 15 a season; 4 quail a day, 20 a season; 2 pheasants a day, 6 a season; 3 ruffed grouse a day, 15 a season; 4 woodcock, 12 ducks (but not more than 5 eider ducks, and 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, 20 Wilson's snipe, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails and gallinules (other than sora and coot) a day. A resident may possess for his own use during the close season game legally taken by himself, but migratory game birds may be possessed only during the open season and first 10 days of close season. Not more than two days' limit of migratory waterfowl and not more than 12 woodcock may be possessed at any one time. Game taken outside of State and legally exported may be possessed for personal use.

Interstate transportation: A nonresident under his license may take out fish and game lawfully taken if carried open to view. A resident may export all game lawfully killed, but not more than two days' bag limit of migratory birds may be exported in any one calendar week.

Miscellaneous: Unlawful to take wild birds on any waters or shores that have been baited with grain.

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[8] *Maryland:* A number of local restrictions apply to the hunting of waterfowl, especially on Susquehanna Flats and Patuxent River, information concerning which may be obtained from the State game warden, Munsey Building, Baltimore.

MICHIGAN

Open seasons:[9]	*Dates inclusive*
Deer (male with horns not less than 3 inches above skull), in Upper Peninsula, and in Alcona, Alpena, Antrim, Arenac, Bay, Cheboygan, Crawford, Charlevoix (except Beaver Island), Emmet, Gladwin, Iosco, Kalkaska, Midland, Montmorency, Ogemaw, Oscoda, Otsego, Presque Isle, and Roscommon Counties	Nov. 15–Nov. 30.
In rest of State	No open season.
Bear	Nov. 15–Nov. 30.
Rabbit, varying hare, in Upper Peninsula	Oct. 1–Jan. 31.
In Lower Peninsula	Oct. 15–Jan. 31.
Squirrel, in Upper Peninsula	Oct. 1–Oct. 10.
In Lower Peninsula	Oct. 15–Oct. 24.
Prairie chicken, ringneck pheasant (male), ruffed grouse (partridge), woodcock, in Lower Peninsula	Oct. 15–Oct. 26.
Prairie chicken, ruffed grouse, woodcock, in Upper Peninsula	Oct. 1–Oct. 12.
Ringneck pheasant in Upper Peninsula	No open season.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe, rail, and gallinule	Oct. 1–Nov. 30.

Hunting licenses: Nonresident—deer and bear, $25; small game, $5. Resident—deer and bear, $2.25; small game, $1. Issued by county clerks, director of conservation, or deputy. Camping party (1 deer for use of party of 4 or more), $3; issued by director of conservation.

Bag and possession limits: 1 deer, 1 bear a season; 5 fox squirrels a day, 10 in possession, 15 a season; 5 rabbits a day, 5 in possession in Upper Peninsula, 10 in possession in Lower Peninsula, 50 a season; 5 each of ruffed grouse and prairie chickens a day, 10 each a season or in possession; 2 ringneck pheasants a day, 4 a season or in possession; 12 ducks a day, 24 in possession (but not more than 8 of any one, or, in the aggregate, of the following species: canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall a day; 16 of any one, or in the aggregate, in possession), 100 a season; 4 geese, including brant, a day, 8 a season, but not more than 5 in the aggregate of both in possession; 4 woodcock a day, 8 in possession, 16 a season; 10 Wilson's snipe a day, 20 in possession, 50 a season; 10 coots a day, 20 in possession, 50 a season; 10 rails and gallinules a day, 20 in possession, 50 a season. Deer and bear lawfully killed may be possessed first 60 days of close season; game birds and other animals during first 10 days of close season.

Game taken outside of State and lawfully exported may be possessed in like manner as game taken in State.

Interstate transportation: Export prohibited of all protected game. *Exceptions:* (1) Deer and bear may be transported outside of State to reach a point within State. (2) Nonresident licensee may take out as hand baggage, open to view, possession limit of game birds, rabbits, and squirrels, and may ship one deer and one bear lawfully killed by himself when deer license tag and seal are attached. (3) Heads and skins of deer and bear, green or mounted, lawfully taken, may be exported under permit.

MINNESOTA

Open seasons:[10]	*Dates inclusive*
Deer (season closed in odd, open in even years)	Nov. 15–Nov. 25.
Bear, even years	Nov. 15–Nov. 25.
Odd years	Apr. 15–May 15.
Varying hare or snowshoe rabbit	No close season.
Squirrel (gray or fox)	Oct. 15–Jan. 1.
Chinese ringneck or English phesants, in Traverse, Big Stone, Lac qui Parle, Yellow Medicine, Lincoln, Lyon, Redwood, Brown, Pipestone, Murray, Cottonwood, Watonwan, Blue Earth, Rock, Nobles, Jackson, Martin, Faribault, and Freeborn Counties	Oct. 21–Nov. 5.
In Wabasha, Dodge, Olmsted, Winona, Mower, Fillmore, Houston, Pennington, Red Lake, Polk, Norman, Mahnomen, Clay, Becker, Hubbard, Clearwater, and Beltrami Counties	Oct. 21–Oct. 24.
In Grant, Douglas, Stevens, Pope, Swift, Chippewa, Kandiyohi, Meeker, and Renville Counties	Oct. 21–Nov. 2.
In Waseca, Steele, Le Sueur, Rice, Goodhue, Scott, Dakota, Washington, Anoka, Chisago, Isanti, Kanabec, Mille Lacs, Sherburne, Benton, Morrison, Hennepin, Wright, McLeod, Carber, Sibley, Nicollet, Stearns, Todd, Wadena, Ottertail, and Wilkin Counties	Oct. 21–Oct. 29.
In Carlton, Pine, Aitkin, Crow Wing, and Cass Counties	Oct. 21–Oct. 26.
In rest of State	No open season.
Ruffed grouse (partridge), in Beltrami, Koochiching, Cass, Itasca, St. Louis, Lake, and Cook Counties	Oct. 21–Nov. 5.
In Roseau, Lake of the Woods, Clearwater, Hubbard, Crow Wing, Aitkin, Carlton, Pine, Chisago, Isanti, Kanabec, Mille Lacs, Morrison, and Goodhue Counties	Oct. 21–Oct. 31.
In Marshall, Polk, Pennington, Red Lake, Norman, Mahnomen, and Becker Counties	Oct. 21–Oct. 25.
In Winona and Houston Counties	Oct. 21–Oct. 24.
In rest of State	No open season.
Quail, in Sherburne, Anoka, Washington, Wright, Carver, Sibley, Scott, LeSueur, Wabasha, Winona, and Houston Counties	Oct. 21–Nov. 12.
In rest of State	No open season.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 1–Nov. 30.
Rail and gallinule, other than coot	Sept. 16–Nov. 30.

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[9] *Michigan:* Director of conservation may shorten or close seasons and otherwise restrict taking of game for period not to exceed five years in any county.

[10] *Minnesota:* Seasons subject to change by regulation. All hunting prohibited within 3 miles of corporate limits of Duluth, Minneapolis, and St. Paul.

Hunting licenses: Nonresident or alien—big game, $50.25; small game, $25. Resident—big game, $2.25; small game, $1. Issued by commissioner, county auditors, and agents.

Bag and possession limits: 1 deer a season; 7 squirrels a day, 14 in possession; 3 pheasants a day, 18 a season, 12 in possession; 5 ruffed grouse (partridge) a day, 30 a season, 10 in possession; 10 quail a day, 30 a season, 15 in possession; 12 each of ducks, coots, rails, and jacksnipe a day, but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall; 2 days bag of ducks, may be possessed at one time; 4 geese, including brant, a day, 5 in possession. Not more than 15 in the aggregate of all game birds may be taken in one day. Possession permitted during first five days of close season. Under permit and tag deer may be possessed until February 28, and migratory game birds may be possessed for 10 days after close of season, but no game birds may be possessed later than January 10. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game prohibited, except that nonresident licensee may ship home in open season under his license coupons 1 deer and 25 birds lawfully taken by himself, but not more than the possession limit of any one species a season; not more than 5 geese, including brant, may be exported by one licensee. Deer hides for tanning and heads for mounting may be exported when tagged with license coupons (deer season closed in odd years).

Miscellaneous: Unlawful to hunt or attempt to hunt migratory waterfowl, or to molest, harry, or worry such waterfowl by discharging firearms or other noise-producing devices, within 300 yards of any area that has been baited with natural or prepared grains.

MISSISSIPPI

Open seasons:	*Dates inclusive*
Deer (male), fox, opossum, raccoon, squirrel, rabbit, quail, wild turkey gobbler (see exceptions)	Nov. 20–Jan. 31.
Exceptions: Deer, in Panola, Quitman, and Tallahatchie Counties	Nov. 21–25; Dec. 27–29; Jan. 17–19.
Deer, in Neshoba, Leake, Scott, Rankin, Madison, Newton, and Hinds Counties	No open season.
Mourning dove	Sept. 1–Sept. 30, Nov. 20–Jan. 31.
Woodcock	Dec. 1–Dec. 31.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose). brant, coot, Wilson's snipe or jacksnipe	Nov. 16–Jan. 15.
Rails and gallinules, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $25.25 (State); $10.25 (county). Resident, $3.25 (State); $1.25 (county). Issued by game and fish commission, sheriffs, and wardens.

Bag and possession limits: 1 male deer, 1 wild turkey gobbler a season; 10 rabbits a day; 8 squirrels a day, 24 in possession; 12 quail a day; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese (including brant), 20 Wilson's snipe, 4 woodcock, 18 doves, 25 coots, 25 sora, 25 of other rails (except sora) and gallinules, but not more than 15 of any one species of rails and gallinules (other than sora and coot), a day. Not more than 2 days' bag limit of ducks and geese and not more than 12 woodcock may be possessed at one time.

Interstate transportation: Export of all protected game prohibited, except rabbits and the skins of raccoons and opossums may be exported November 20 to January 31. Nonresident licensee may ship or carry out of State during open season 1 buck deer, 20 rabbits, 16 squirrels, raccoons, and opossums in possession, 30 quail, 1 turkey gobbler, and, in 1 calendar week, not to exceed 2 days' bag limit of migratory game birds (3 days' limit of woodcock). Packages must have attached an affidavit that game was lawfully killed, is being shipped to licensee's home, and is not for sale.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

MISSOURI

Open seasons:	*Dates inclusive*
Deer (male, with 4 or more points to 1 antler), 3 days only	Oct. 26–Oct. 28.
Squirrel	June 1–Nov. 30.
Wild turkey	Dec. 1–Dec. 31.
Quail (bobwhite) (see exceptions)	Nov. 10–Dec. 31.
Exceptions: In Andrew, Atchison, Bates, Cooper, Dade, Daviess, De Kalb, Harrison, Johnson, Knox, Maries, and Moniteau, Counties	No open season.
In Cass County	Dec. 4–Dec. 31.
Dove	Sept. 1–Dec. 15.
Woodcock	Nov. 10–Dec. 10.
Duck (except wood duck ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.
Rail and gallinule, other than coot	Sept. 15–Nov. 30.

Hunting licenses: Nonresident or alien, $10; issued by commissioner or county clerk. Resident—State, $2.50; county, $1 (county of residence or adjoining county). Issued by county clerk or license collector. Special deer tag required in addition to hunting license—resident, $1.50, nonresident, $50.

Bag and possession limits: 1 deer, 1 turkey a season; 10 squirrels, 10 quail, 10 doves, 12 ducks (but not more than 8 of any one, or in aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, including brant, 4 woodcock, 15 Wilson's snipe, a day; 15 rails, 15 coot, 15 gallinules, a day. One turkey, 15 quail, 15 doves, 8 geese, including brant, and 25 of any other species of game birds, in possession, but not more than 12 woodcock and not more than 2 days' limit of ducks in possession at one one time. Possession of migratory game birds permitted during first 10 days of close season, other game during first 5 days, but tagged carcass of deer may be possessed until February 5.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game prohibited, except that not more than 2 days' limit of game may be exported under resident or nonresident license if carried openly as baggage or express or in owner's possession and accompanied by him.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

MONTANA

Open seasons:	*Dates inclusive*
Deer (male, with horns not less than 4 inches long) (see exceptions)	Oct. 15–Nov. 15.
Exceptions: In Carter, Custer Dawson, Fallon, Prairie, Richland, Roosevelt, and Wibaux Counties	Nov. 1–Nov. 3.
In part of Ravalli County (either sex)	Sept. 20–Oct. 20.
In part of Glacier County (either sex)	Oct. 15–Nov. 15.

Open seasons—Continued.	*Dates inclusive*
Deer—Continued.	
Exceptions—Continued.	
In Blaine, Carbon, Daniels, Garfield, Liberty, McCone, Musselshell, Petroleum, Phillips, Powder River, Rosebud, Sheridan, Teton, Toole, Treasure, Valley, Yellowstone, and parts of Big Horn, Gallatin, Glacier, and Pondera Counties	No open season.
Elk, in Flathead, Glacier, Pondera, Petroleum, and Madison Counties; part of Missoula, Powell, and Gallatin Counties, and one of either sex in part of Mineral County	Oct. 15–Nov. 15.
In Park County	Oct. 15–Jan. 10.
In part of Ravalli County	Sept. 20–Oct. 20.
In part of Granite County (either sex)	Nov. 12–Nov. 15.
In part of Lewis and Clark County	Nov. 1–Nov. 15.
In part of Lewis and Clark and Teton Counties	Oct. 15–Dec. 1.
In rest of State	No open season.
Bear (unlawful to trap)	No close season.
Grouse (sharp-tailed, blue, ruffed, fool hen), prairie chicken, sage hen	Sept. 16–Sept. 25.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 1–Nov. 30.
Rails and gallinules, other than coot	Sept. 16–Nov. 30.

Hunting licenses: Resident—class A, game birds and fishing, $2; class AA game animals, $1 (issued only to holder of class A license); class AAA ("sportsman's license"), general hunting and fishing, $5. Nonresident—Class B–1, game birds, $10; class B–2, general hunting, $30. Alien—Class C–1, game birds, $30; class C–2, game animals, $50. Guide (resident citizen only), $10. Issued by warden, deputies, justices of the peace, and agents. Alien not holding class C–2 license must obtain from warden license to own or possess firearms (fee, $25).

Bag and posssesion limits: 1 deer, 1 elk a season; 5 in all of grouse, partridges, fool hens, pheasants, and sage hens a day or in possession; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, including brant, 20 Wilson's snipe, 25 coots, 25 sora, 25 in all of other rails and gallinules but not more than 15 of any 1 species of rails (other than sora) and gallinules, a day. Migratory game birds may be possessed during first 10 days of close season, but not more than two days' limit of ducks and geese may be possessed at any one time. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game prohibited; provided, game lawfully killed may be exported by a resident under shipping permit (fee, 50 cents) from State warden; a nonresident may export under his license game he has lawfully taken; total shipments under permits or one license may not exceed season's bag limit and not more than 2 days' limit of migratory birds may be exported in any one calendar week; packages must be labeled to show contents.

NEBRASKA

Open seasons:[11]	*Dates inclusive*
Squirrel	Sept. 15–Dec. 31.
Rabbit	No close season.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, rail, and gallinule	Oct. 1–Nov. 30.
Wilson's snipe or jacksnipe	Oct. 1–Nov. 1.

Hunting licenses: Nonresident, $10.10; resident, $1.10. Issued by game, forestation, and parks commission and authorized vendors.

Bag and possession limits: 10 squirrels a day or in possession; 5 pheasants a day or in possession; 20 ducks and coot combined a day, but not more than 12 ducks a day, except that not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall—may be taken in 1 day; 4 geese, including brant, a day, 5 in possession; 15 Wilson's snipe a day or in possession; 25 in all of rails and gallinules a day, but not more than 15 of each a day or in possession. Not more than 2 days' bag limit of ducks may be possessed at one time. Game taken outside of State and legally exported may be possessed in like manner as game taken in State, but migratory game birds may be possessed only during open season and first 10 days of close season.

Interstate transportation: Game may be transported by express or baggage during the open season when tagged as required by commission, and shipper's statement that the game is not for sale or profit, and was not taken contrary to law, is furnished commission and a copy attached to shipment; package must be labeled with consignor's license number and kind of game, consigned to shipper, and accompanied by him; shipment must not contain more than 40 game birds or the possession bag limit on any species. Not more than two days' limit of migratory birds may be exported in any one calendar week.

NEVADA

Open seasons:[12]	*Dates inclusive*
Deer (male, with branched horns) (see exception)	Oct. 1–Oct. 30.
Exception: In Washoe County	Oct. 15–Nov. 13.
Bear, squirrel	No close season.
Rabbit, hare	Nov. 1–Dec. 31.
Quail, pheasant	Nov. 1–Nov. 10.
Dove	Sept. 1–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 1–Nov. 30.
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident citizen and declarant alien, $10; alien, $25; resident citizen, $2.50. Deer tags ($1) required of holders of licenses to hunt deer. Issued by county clerks and wardens.

Bag and possession limits: 1 deer a season; 5 rabbits, 2 hares, 10 valley quail, 5 mountain quail, 3 partridges, 3 pheasants, 10 sagehens, 3 grouse, 5 prairie chickens, 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall) a day; 4 geese, including brant, 10 Wilson's snipe, 18 doves, 25 coot, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, a day. Possession limited to 1 day's bag limit, except that 8 in the aggregate of geese and brant, but not more than 5 of either, may be possessed at one time. One day's limit of game lawfully taken may be possessed, under permit, during first 60 days of close season, except that migratory game birds may be possessed only during first 10 days of close season. Deer lawfully taken in another State may be personally brought into State by the taker during close season, and game taken outside of State and lawfully exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game prohibited, except one day's limit may be exported under permit, if not for sale.

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[11] *Nebraska:* Game, Forestation, and Parks Commission, upon written request from any county board, may open season on pheasants, prairie chickens, and grouse in such county for 15 days or less between Sept. 16 and Dec. 31.

[12] *Nevada:* Fish and game commission fixes open seasons on deer and upland game birds, and county commissioners may shorten or close season entirely on all game.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

NEW HAMPSHIRE

Open seasons:	*Dates inclusive*
Deer (see exceptions)	Dec. 15–Dec. 31.
Exceptions: In Coos County north of U.S. Highway No. 2 from Shelburne to Lancaster	Oct. 15–Nov. 30.
In Grafton County, and in Coos County south of U.S. Highway No. 2	Nov. 1–Dec. 15.
In Carroll County	Nov. 15–Dec. 15.
In Cheshire County	Dec. 1–Dec. 15.
In towns of Seabrook, Hampton, Hampton Falls, North Hampton, and Rye, in Rockingham County	No open season.
Bear	Oct. 15–Dec. 1.
Hare, rabbit	Oct. 1–Feb. 28.
Partridge, ruffed grouse	Oct. 1–Nov. 30.
Pheasant (male) in Hillsborough, Merrimack, Rockingham, and Strafford Counties only	Nov. 1–Nov. 6.
Quail	Oct. 15–Nov. 15.
Woodcock	Oct. 1–Oct. 31.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's, and snow geese, and brant), coot, Wilson's snipe or jacksnipe	Oct. 1–Nov. 30.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.
Gallinule	Sept. 16–Nov. 30.

Hunting licenses: Nonresident, game and fish, $15.15; resident, game and fish, $2. Guide—nonresident, $20; resident, $1. Issued by commissioner or his agent, who, with few exceptions, is the town clerk.

Bag and possession limits: 1 deer a season; 3 hares, 5 rabbits, but not more than 5 in all, a day; 5 ruffed grouse a day, 25 a season; 5 quail a day; 2 pheasants a day, 5 a season; 4 woodcock a day, 25 a season; 12 ducks (but not more than 5 eiders, nor more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall) a day; 4 geese, 20 Wilson's snipe, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, a day. Not more than two days' bag limit of ducks and geese and not more than 12 woodcock may be possessed at one time. Deer may be possessed for a reasonable time after close of season. Migratory game birds may be possessed during first 10 days of close season. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game prohibited, provided, head, hide, feet, or fur of game quadrupeds, and plumage or skins of game birds (except migratory birds) legally taken and possessed may be transported in State without being marked, but under Federal laws all interstate shipments must be marked as to contents. Nonresident may take or ship out of State, under his hunting license, 1 day's limit of game birds, and under license coupon, one deer. Shipments by common carrier must have attached tag showing number and kind of game, names of consignor and consignee, and point of shipment and destination, and shipment or transportation of game must be indorsed on back of shipper's license. Carcass of deer shipped by nonresident must have license coupon attached.

NEW JERSEY

Open seasons:	*Dates inclusive*
Deer (male, with horns not less than 3 inches long)	Dec. 17-Dec. 21.
Raccoon (may not be hunted during deer season)	Nov. 1-Dec. 31.
Rabbit, gray, fox, and black squirrels, quail, ruffed grouse (partridge), prairie chicken, English or ring-necked pheasant cocks (see exceptions)	Nov. 10-Dec. 15.
Exceptions: Quail in Bergen, Essex, Hudson, Hunterdon, Morris, Passaic, Somerset, Sussex, Union, and Warren Counties	June 21, 1938.
Ruffed grouse in Essex, Hunterdon, Mercer, Middlesex, Monmouth, Somerset, and Union Counties	Mar. 9, 1935.
Woodcock	Oct. 15-Nov. 14.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's and snow geese and brant), coot, Wilson's snipe or jacksnipe	Nov. 16-Jan. 15.
Rail and gallinule, other than coot	Sept. 1-Nov. 30.

Hunting licenses: Nonresident and alien, $10.50; resident, hunting and fishing, $3.15; resident, hunting only, $2.15. Issued by county, city, and town clerks, salaried wardens, and registrars of licenses. Special license to hunt woodcock between October 15 and November 9 (fee $2) required in addition to regular hunting license; issued by commission. Alien prohibited from hunting or owning shotgun or rifle unless he is owner of real property in State valued at $2,000 or over, above encumbrances, in which case he may obtain nonresident and alien license.

Bag and possession limits: 1 deer a season; 15 raccoons a season; 2 pheasant cocks a day, 30 a season; 6 rabbits, 6 squirrels, 10 quail, 3 ruffed grouse, 4 woodcock, 20 snipe, 25 sora, 25 coots, and 25 in all of other rails and gallinules (but not more than 15 of any one species of rails, other than sora, and gallinules), a day or in possession; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese a day. Not more than 2 day's limit of ducks and geese and not more than 12 woodcock may be possessed at one time. Carcass of deer from another State or from State game preserve may be possessed at any time if properly tagged; possession of other game permitted during first 10 days of close season. Game taken outside of State and legally exported may be possessed at any time, but migratory game birds may be possessed only during first 10 days of close season.

Interstate transportation: Export of all protected game (except deer) prohibited, except that a nonresident licensee in 1 day may carry from State the daily bag limit of game, if open to view, but not more than 2 days' limit of game may be exported in 1 calendar week.

NEW MEXICO

Open seasons:	*Dates inclusive*
Deer (with horns at least 6 inches long), squirrel, wild turkey (see exception)	Oct. 25–Nov. 15.
Exception: Deer and turkey in McKinley County	No open season.
Elk [13]	Nov. 6–Nov. 15.
Antelope,[13] in Catron and Socorro Counties only	Oct. 1–Oct. 5.
Bear	Oct. 25–Dec. 10.[14]

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[13] *New Mexico:* State game warden may issue special permits (fee $5 each) to holders of big game hunting licenses, to take one buck antelope in a restricted area in Catron and Socorro Counties only, and elk in a designated area, under special permit (fee $10).

[14] In area bounded on east by Rio Grande, and on south and west by Chama River and El Vado-Dulce Railway, bears may be taken Oct. 1–Dec. 10.

Open seasons—Continued.	*Dates inclusive*
Quail (except bobwhite) (see exception)	Nov. 10–Dec. 10.
Exception: In McKinley County	No open season.
Prairie chicken	Sept. 1–Sept. 5.
Dusky or blue grouse	Oct. 1–Oct. 10.
Doves	Sept. 1–Dec. 15.
Band-tailed pigeon	Nov. 1–Nov. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe, in northern zone [15]	Oct. 16–Dec. 15.
In southern zone [15]	Nov. 16–Jan. 15.
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident—general hunting and fishing, $35.25; general hunting, $30.25; big game, $25.25; bird, $10.25. Resident—general hunting and fishing, $5; general hunting, $4.50; big game, $3; bird, $2.50. Guide, $5.25. Duplicate license, $1. Issued by county clerks and designated deputy game wardens. Alien not permitted to hunt or own or possess shotgun or rifle in State.

Bag and possession limits: 1 deer, 1 bear, 5 squirrels, 2 wild turkeys, 10 prairie chickens, 5 grouse, a season or in possession; 12 quail a day or in possession; 5 prairie chickens a day; 15 doves, 10 band-tailed pigeons, 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, including brant, 20 Wilson's snipe, 25 coot, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, a day or in possession, except that not more than 2 days' bag limit of ducks and geese including brant, may be possessed at any one time.

Under permit game, except migratory game birds, may be held in storage first 90 days of close season, but migratory birds may be possessed only during first 10 days, and deer carcass until January 31 if tag accompanying license is attached.

Game taken outside of State and legally exported, when accompanied by proof of lawful possession, may be retained under permit for first 30 days of close season, but migratory game birds may be retained only during first 10 days.

Interstate transportation: Licensee may carry out of State during open season game legally killed, but permits issued by State game warden and license collectors are required to ship game out by common carrier: Fee, $1.25 for 1 deer, 1 bear, and 2 turkeys, and 50 cents for bag limit of other birds and fish.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

NEW YORK

Open seasons:	*Dates inclusive*
Deer (with horns not less than 3 inches long), in Adirondack [16] region	Oct. 15–Nov. 15.
In Ulster, Sullivan, Rensselaer, Delaware, Columbia, Orange, Schoharie, Dutchess, and Greene Counties	Nov. 1–Nov. 15.

Open seasons—Continued.	*Dates inclusive*
Deer—Continued.	
In rest of State	No open season.
Bear [17]	Oct. 15–Nov. 15.
Varying hare (see exceptions)	Oct. 15–Jan. 31.
Exceptions: In Cattaraugus, Chautauqua, and Fulton Counties	Oct. 26–Jan. 31.
In Allegany County	No open season.
Rabbit (see exceptions)	Oct. 15–Jan. 31.
Exceptions: In Wayne, Ontario, Orleans, Livingston, Monroe, Cayuga, Schuyler, Tompkins, and Onondaga Counties	Oct. 15–Mar. 31.
In Niagara County	Oct. 26–Dec. 31.
In Rockland County	Nov. 15–Jan. 15.
Squirrel (black, gray) (see exception)	Oct. 15–Nov. 15.
Exception: In Genesee, Niagara, Orleans, and Yates Counties	No open season.
Quail, in Dutchess, Greene, Putnam, and Westchester Counties only	Nov. 15–Nov. 30.
Grouse or partridge	Oct. 15–Nov. 15.
Pheasant (male only)	Oct. 30–Nov. 4.
Woodcock, north of main track of New York Central R. R., from Buffalo to Albany, and Boston & Albany R. R., to Massachusetts line	Oct. 1–Oct. 31.
In rest of State	Oct. 15–Nov. 14.
Waterfowl (except wood duck, ruddy duck, and bufflehead; Ross's and snow geese and brant), coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.
Rail and gallinule, other than coot	Oct. 1–Nov. 30.

Hunting licenses: Nonresident (combined hunting, fishing, and trapping), $10.50; resident, $2.25. Special deer license—Nonresident or alien, $10.50; resident, $1.25. Issued by county, city, and town clerks where population exceeds 5,000; elsewhere, by Department of Conservation inspectors and protectors. Indian resident or memebr of Six Nations residing on any reservation wholly or partly in State, $2.25. Guide (required in forest reserve counties), $2; issued by Conservation Department. Alien not permitted to hunt except under special license from Conservation Department, or to own or possess shotgun or rifle.

Bag limits: 1 deer, 1 bear, a season; 4 quail a day, 10 a season; 3 grouse or partridges a day, 15 a season; 2 male pheasants a day, 6 a season; 4 woodcock, 6 varying hares or rabbits, 5 squirrels, a day; 12 ducks (but not more than 5 eiders, nor more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, teal, ringneck, shoveler, and gadwall), 4 geese, 25 in all of rails and gallinules, but not more than 15 of any one species of rails (except sora) and gallinules, a day; 5 coots, 25 sora, 20 Wilson's snipe, or jacksnipe a day.

Possession: Deer, bear, squirrel, grouse, and pheasant may be possessed during open season and 5 days thereafter; migratory game birds during open season and 10 days thereafter, but not more than 2 days' bag limit of ducks and geese and not more than 12 woodcock may be possessed at any one time. Deer and bear properly tagged may be possessed under permit (fee $1) until February 1. Game taken outside of State and legally exported may be imported during the open season and possessed in like manner as game taken in State, except migratory game birds may be possessed only during open season where taken and for 10 days thereafter. Permit (fee $1) from Conservation

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[15] Waterfowl zones are divided by line running from a point near Nara Visa where Southern Pacific Railway crosses State line; then following main track of the railway to Tularosa; then following State Highway no. 52 to Elephant Butte Dam; then running west through Hot Springs and Hermosa to northeast corner of Grant County; then following north line of Grant County to State boundary.

[16] *New York:* The Adirondack region comprises the counties of Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Jefferson, Lewis, Onieda, Oswego, Saratoga, St. Lawrence, Warren, and Washington.

[17] Bear unprotected in Clinton, Delaware, Essex, Franklin, Greene, and Ulster Counties, but bear taken in those counties between Nov. 21 and Oct. 15 may be possessed only under license and by marking and tagging as provided for animals taken during open season elsewhere in State.

Department required for importation of game during close season, and then game birds must be accompanied by the taker, but quadrupeds bearing State tags may be shipped by common carrier but not by parcel post. Game, other than migratory game birds, imported under permit may be possessed at any time by permit holder for private consumption.

Interstate transportation: Export of game and birds prohibited except that any person may export 1 deer, 1 bear, and 1 days' limit of other game in 1 day during open season by means other than parcel post. The taker may export in 1 day by common carrier, except parcel post, 1 day's limit when accompanied by permit, which shall show contents of package. Head, hide, and feet of animals and plumage or skin of game birds legally taken may be exported at any time.

NEW YORK—Long Island

Open seasons:	*Dates inclusive*
Squirrel (black, gray), varying hare, rabbit, quail, pheasant (male), grouse	Nov. 1–Dec. 31.
Woodcock	Oct. 15–Nov. 14.
Waterfowl (except wood duck, ruddy duck, and bufflehead; Ross's and snow geese and brant), coot, mud hen, Wilson's snipe or jacksnipe	Nov. 1–Dec. 31.
Rail and gallinule, other than coot	Oct. 1–Nov. 30.

Bag and possession limits: 6 quail a day, 40 a season; 4 male pheasants a day, 30 a season. For other bag limits, see New York.

Hunting licenses and **Interstate transportation,** see New York.

NORTH CAROLINA

Open seasons: [18] [19]	*Dates inclusive*
Deer (male), in western and central zones	Oct. 15–Dec. 15.
In eastern zone	Sept. 1–Dec. 15.
Bear, in western and central zones	Oct. 1–Jan. 15.
In eastern zone	No close season.
Rabbit, in western zone	Nov. 15–Jan. 1.
In central zone	Nov. 20–Feb. 20.
In eastern zone	Nov. 20–Feb. 1.
Squirrel, in western zone	Oct. 1–Nov. 30.
In central and eastern zones	Oct. 1–Dec. 31.
Raccoon, opossum	Nov. 1–Jan. 31.
Quail, turkey, in western zone	Nov. 15–Jan. 1.
In central zone	Nov. 20–Feb. 20.
In eastern zone	Nov. 20–Feb. 1.
Dove	Sept. 1–Sept. 30, Nov. 20–Jan. 31.
Woodcock	Dec. 1–Dec. 31.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's and snow geese and brant), coot, Wilson's snipe or jacksnipe	Nov. 16–Jan. 15.[20]
Rail and gallinule other than coot	Sept. 1–Nov. 30.
Local seasons (upland game only):	
In Halifax, Northampton, Hertford, Person, Martin, Bertie, and Washington Counties:	
Deer	Sept. 1–Jan. 1.
Raccoon	Oct. 1–Feb. 1.
Squirrel	Sept. 15–Feb. 1.
Quail, turkey	Nov. 20–Feb. 20.
In Bertie, Bladen, and Duplin Counties, rabbit	No close season.
In Beaufort County:	
Deer	Sept. 15–Dec. 31.
Squirrel	Oct. 15–Dec. 31.
All other game	Nov. 15–Jan. 31.
In Bladen County:	
Deer	Oct. 15–Nov. 30.
Bear	No close season.
Squirrel	Oct. 15–Jan. 1.
Quail	Nov. 20–Jan. 31.
Turkey	Oct. 15–Jan. 1.
In Catawba County:	
Quail	No open season.
All other game	Nov. 20–Feb. 1.
In Cumberland, Transylvania, Harnett, and Nash Counties, all game	Nov. 20–Feb. 20.
In Graham County, raccoon, opossum	Nov. 1–Feb. 15.
In Yadkin County, quail	Dec. 1–Dec. 31.

Hunting licenses: Nonresident or alien: Game, $10.10. Nonresident owning land in State may obtain license to hunt thereon, fee, $5.25. Resident (State licenses): Game, $2.10. County licenses: Game, 60¢. Hunting guide license, $5. Issued by superior court clerks, wardens, and deputies.

Bag and possession limits: 2 deer a day or in possession at one time, 4 a season; 2 wild turkeys a day or in possession at one time, 5 a season; 10 squirrels, 10 quail, 4 woodcock, 18 doves, 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, 20 Wilson's snipe, or jacksnipe, and 25 in all of rails, coots, and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day.

The game allowed in possession at one time is restricted to one day's limit on deer and wild turkeys, two days' limit on other game animals and birds, and to 12 woodcock.

Rabbits and squirrels lawfully taken may be possessed during open season and first 5 days of close season. Other game animals and birds may be possessed during open season and first 10 days of close season.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game (except rabbits during open season) prohibited, except that a nonresident licensee, under permit from State warden may export not more than 2 male deer and 2 wild turkeys a season and not more than 2 days' limit of other game animals and birds (3 days' limit of woodcock) a calendar week in any manner except by parcel post, if outside of package in which such game is transported is clearly marked with names and addresses of consignor and consignee and an accurate statement of number and kind of game contained therein.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

NORTH DAKOTA

Open seasons:[21]	*Dates inclusive*
Deer (male) (see exception)	Nov. 16–Nov. 25.
Exception: In Bowman, Slope, Billings, Golden Valley, McKenzie south of Township 150, Divide, Burke, Renville, Ward, Bottineau west of Range 76, McHenry, Pierce, Benson, Ramsey, Towner, Cavalier, Nelson, Grand Forks, Walsh, and Pembina Counties	No open season.

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[18] *North Carolina:* Western Zone comprises Alleghany, Ashe, Watauga, Avery, Mitchell, Yancey, Buncombe, and Henderson Counties and all counties west thereof; Eastern Zone comprises Halifax, Nash, Johnston, Harnett, Hoke, and Scott Counties, and all counties east thereof; Central Zone comprises rest of State.

[19] Season closed throughout State on ruffed grouse and pheasant.

[20] Rest days prescribed for waterfowl by certain county laws. Special regulations affecting waterfowl in Currituck, Dare, and Hyde Counties may be obtained from clerks of counties named.

[21] *North Dakota:* The governor, on recommendation of game and fish commissioner, may by order close or open seasons, fix bag limits, or prescribe manner in which game may be taken, but such orders may not extend the open seasons or other provisions of the Federal regulations on migratory birds.

Open seasons—Continued.	*Dates inclusive*
Prairie chicken (pinnated grouse), sharp-tailed (white-breasted) grouse	Sept. 16–Oct. 16.
Ruffed grouse, in Bottineau, Cavalier, Pembina, and Rolette Counties	Oct. 7–Oct. 16.
Chinese ringneck, Mongolian, and English pheasants (male)	Oct. 15–Nov. 1.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Sept. 21–Nov. 20.

Hunting licenses: Nonresident, big game (deer), $50; hunting, $25. Resident, big game (deer), $5; hunting, $1.50. Issued by game and fish commissioner, deputy, or county auditor. Alien not permitted to hunt.

Bag and possession limits: Pinnated grouse, (prairie chicken), sharp-tailed grouse, ruffed grouse, 5 of each or all combined a day, but not more than 10 of each or all combined in possession. Four geese a day, including brant, 8 in possession. Ducks, 12 of each or all combined a day (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), and not more than 2 days' bag limit of each or all combined in possession; 10 jacksnipe, 12 coots, 3 male pheasants, a day. Resident licensee may, ship or carry with him to his own home 2 days' bag limit of game lawfully taken.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State. Upland game birds may be possessed 30 days, migratory game birds 10 days, and deer 90 days after close of season.

Interstate transportation: Export of all protected game prohibited, except that resident licensee may, under special permit, ship to any point within or without State, other than his own home, 10 protected game birds a season; but not more than 8 wild geese, including brant, may be shipped in any 1 calendar week. Nonresident licensee may carry with him from State under license tag 2 days' limit of game, if open to view and labeled with his name and address and number of his license. Not more than 2 days' limit of migratory birds may be exported in any one calendar week.

OHIO

Open seasons:	*Dates inclusive*
Hare, rabbit	Nov. 15–Jan. 1.
Squirrel	Sept. 15–Oct. 1.
Introduced pheasant (male), Hungarian partridge	Nov. 15–Nov. 25.
Woodcock	Oct. 15–Nov. 14.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe, gallinule	Oct. 1–Nov. 30.
Rail, other than coot and gallinule	Nov. 1–Nov. 30.

Hunting licenses: Nonresident citizen, $15.25; resident citizen, $1.25. Issued by county and township clerks.

Bag and possession limits: 4 squirrels and 5 rabbits a day or in possession; 2 cock pheasants a day, 4 in possession; and 4 Hungarian partridges, 15 Wilson's snipe, 4 woodcock, 4 geese including brant, 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, and not more than 25 coots and gallinules a day. Waterfowl, coots, and gallinules may be possessed during first 10 days of close season, but not more than two days' bag limit of ducks and geese, including brant, and not more than 12 woodcock may be possessed at any one time. Woodcock and jacksnipe may be possessed only during open season.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export prohibited of all protected game (except rabbit) taken in State; provided, a nonresident may take with him from State under his hunting license 25 game animals killed by himself. Packages containing game or furbearing animals or parts thereof must be marked to show contents, initial point of billing, and names and addresses of consignor and consignee.

OKLAHOMA

Open seasons:	*Dates inclusive*
Squirrel	May 15–Dec. 31.
Quail [22]	Nov. 20–Jan. 1.
Dove	Sept. 1–Dec. 15.
Woodcock	Nov.15–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $15. Nonresidents in States bordering on Red River may procure special license (fee, $2.50) to hunt migratory waterfowl on Red River within borders of Oaklahoma. Alien, $25. Resident citizen, $1.25. Issued by warden, deputy, or county clerk.

Bag and possession limits: 10 squirrels a day 10 quail a day, 50 a season; 10 ducks a day, 50 a season, but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall—a day; 4 geese, including brant, a day, 12 a season; 20 Wilson's snipe a day, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, 25 doves, and 4 woodcock a day. Not more than 2 days' bag limit of ducks and geese, including brant, and not more than 12 woodcock, may be possessed at any one time. Possession of game permitted during first 10 days of close season, and trophies or specimens of game lawfully taken may be possessed at any time.

Game taken outside of State and lawfully exported may be possessed in like manner as game taken in State.

Interstate transportation: Export prohibited of all protected game, but nonresident licensee may carry to his home two days' bag limit of game birds if license permit is attached.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

OREGON

Open seasons: [23]	*Dates inclusive*
Deer (male, with forked horns)	Sept. 20–Oct. 25.
Bull elk, in Umatilla, Baker, and parts of Wallowa and Union Counties only	Oct. 23–Oct. 25.
Bear, in Jackson, Josephine, and Klamath Counties only	Nov. 1–Nov. 30.
Silver-gray squirrel (see exception)	Sept. 15–Oct. 20.
Exception: In Benton, Clackamas, Douglas, Lane, Linn, Marion, Multnomah, Polk, Washington, Wasco, and Yamhill Counties	No close season.

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[22] *Oklahoma:* Quail may not be hunted except on Monday, Wednesday, and Friday of each week during open season and on Thanksgiving Day and on Christmas and New Year's Days or the preceding Saturdays if these fall on Sundays.

[23] *Oregon:* Unlawful to kill geese or other wild bird or animal at any time on islands or sand bars or within one-fourth mile of high-water line on Columbia River east of eastern entrance of Celilo Canal in Wasco County, and extending easterly along Columbia River to Oregon-Washington boundary in Umatilla County, or on islands and sand bars in Deschutes and John Day Rivers from Columbia River to point half a mile south of Oregon Trail highway bridges where the highway crosses said rivers, respectively.

Open seasons—Continued.	*Dates inclusive*
Mountain, or plumed, and California, or valley, quail, in Yamhill, Marion, Wasco, Sherman, Gilliam, Morrow, Umatilla, Deschutes, Crook, Lake, Klamath, Jackson, Josephine, Curry, Coos, and Douglas Counties only	Oct. 15–Oct. 31.
Bobwhite quail, in Malheur County only	Nov. 1–Nov. 15.
Blue or sooty grouse, ruffed grouse or native pheasant, in Clatsop, Columbia, Tillamook, Washington, Multnomah, Clackamas, Yamhill, Lincoln, Polk, Marion, Linn, Benton, Lane, Douglas, Coos, Curry, Josephine, and Jackson Counties	Oct. 15–Oct. 31.
In Wasco, Sherman, Gilliam, Morrow, Umatilla, Wheeler, Jefferson, Deschutes, Crook, Klamath, Harney, Lake, and Malheur Counties; and sooty or blue grouse only in Grant County	Sept. 20–Oct. 25.
In Baker, Union, and Wallowa Counties	Aug. 20–Sept. 20.
In Hood River County	No open season.
Hungarian partridge, in Baker, Malheur, Morrow, Sherman, Umatilla, Wasco, and Wallowa Counties only	Oct. 15–Oct. 31
Chinese pheasant (see exceptions)	Oct. 15–Oct. 31.
Exceptions: In Malheur County	Oct. 15–Nov. 15.
In Klamath County	Oct. 1–Oct. 31.
In Harney County (2 days only)	Oct. 20 and 29.
In Lincoln, Tillamook, Wheeler, Jefferson, Lake, and Curry Counties	No open season.
Duck (except wood duck, ruddy duck, bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.[23]
Rail and gallinule (except coot)	Sept. 1–Nov. 30.

Hunting licenses: Nonresidents, $15. Alien, gun license, $25 (in addition to hunting license). Resident, game and fish, $5; game, $3. Hunting license (fee $1.50 issued to residents between 14 and 18 years of age); authorizes hunting in county of residence and adjoining counties. Issued by county clerks and authorized agents. Guide, $3 (issued only to citizens of United States).

Bag and possession limits: 2 black-tailed, 1 white-tailed or 1 mule deer a season; 5 silver-gray squirrels in 7 consecutive days; 10 quail in 7 consecutive days; 4 in all of ruffed grouse, pheasants, sooty or blue grouse, and Chinese pheasants a day, 8 in 7 consecutive days, but a bag of 8 shall not include more than 1 Chinese pheasant hen; 4 Hungarian partridges a day, 8 in 7 consecutive days; 15 in all of Wilson's snipe, rails, coots, and gallinules, a day 20 in 7 consecutive days; 12 ducks a day (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 20 in 7 consecutive days; 4 geese, including brant, a day, but not more than 2 days' bag limit of ducks and geese, including brant, may be possessed at any one time. Game taken outside of State and legally exported may be imported and possessed as authorized by permit and tag (fee 5 cents) from State game warden, but migratory game birds, properly tagged, whether taken within or without the State, may be possessed only during first 10 days of close season.

Interstate transportation: Export of all protected game prohibited, except when tagged with metal seal and accompanied by permit from State warden showing kind of game and names and addresses of consignor and consignee, but not more than two days' bag limit of migratory game birds may be transported within one calendar week.

PENNSYLVANIA

Open seasons:	*Dates inclusive*
Deer (male, with 2 or more points to 1 antler)	Dec. 1–Dec. 15.
Bear (over 1 year old)	Nov. 10–Nov. 30.
Raccoon (see exception)	Oct. 15–Dec. 15.
Exception: In Adams, Bedford, Berks, Bucks, Carbon, Chester, Cumberland, Dauphin, Delaware, Fayette, Franklin, Fulton Greene, Lancaster, Lebanon, Lehigh, Montgomery, Philadelphia, Washington, and York Counties	Nov. 1–Jan. 1.
Hare, rabbit, black, gray, and fox squirrel	Nov. 1–Nov. 30.[24]
Red or pine squirrel	Nov. 1–Aug. 15.
Wild turkey (see exception), quail, pheasant (except Reeves's pheasant), males only, ruffed grouse	Nov. 1–Nov. 30.[24]
Exception: Wild turkey in Berks, Bradford, Carbon, Clearfield, Dauphin, Jefferson, Lackawanna, Lebanon, Lehigh, Luzerne, Monroe, Northampton, Pike, Schuylkill, Tiogo, Wayne, and Wyoming Counties	No open season.
Blackbird	Nov. 1–Nov. 30.[24]
Woodcock	Oct. 15–Nov. 14.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's and snow geese, and brant), coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.
Rails and gallinules, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident and alien (reciprocal), minimum, $15. Resident, $2. Issued by department of revenue or county treasurer. Taxidermist, $25. Resident aliens not permitted to hunt, or to possess dogs or firearms.

Bag and possession limits: 1 deer a day or season (6 to hunting party); 1 bear a day or season (3 to hunting party); 3 raccoons a day, 10 a season; 3 hares a day, 15 a season; 5 rabbits a day, 30 a season; 6 squirrels a day, 20 a season; 6 quail a day, 24 a season; 2 pheasants (except Reeves's pheasant) a day, 6 a season; 1 wild turkey a day or season; 2 ruffed grouse a day, 12 a season; 4 woodcock a day, 20 a season, 12 in possession; 20 Wilson's snipe a day; 12 ducks a day, 60 a season (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall—may be taken in 1 day and not more than 2 days' limit may be possessed at one time); 4 geese a day, 30 a season, 8 in possession; 15 rails, 15 gallinules, 25 coot a day. Game other than migratory game birds may be possessed during first 30 days of close season, migratory game birds first 10 days.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game taken in State prohibited; provided, a nonresident licensee may take out with him on same conveyance two days' limit of game except elk. Small game must be accompanied by owner and if concealed must be tagged to show name and address of owner, county where killed, and munber of each species in package. Large game may be shipped by express when plainly marked to show name and address of owner and county in which killed. Specimens and trophies of game legally taken may be shipped by parcel post or otherwise to a licensed taxidermist for mounting, if marked to show contents, but no such shipments may be made to points outside the State without a permit. Skins of bears or raccoons may be shipped out of State by parcel post or otherwise if package is marked to show contents.

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[24] *Pennsylvania:* Wild turkeys, male pheasants, ruffed grouse, quail, blackbirds, squirrels, rabbits, and hares may be taken only on Nov. 1, 2, 6, 7, 10, 11, 16, 17, 18, 20, 21, 22, 27, 28, 29, and 30.

RHODE ISLAND

Open seasons:	*Dates inclusive*
Gray squirrel, hare, rabbit	Nov. 1–Dec. 31.
Quail or bobwhite, ruffed grouse or partridge, cock pheasant (see exceptions)	Nov. 1–Dec. 31.
Exception: Cock pheasants in town of New Shoreham (4 days only), Oct. 18, Nov. 1 and 15, and Dec. 6, and in town of Jamestown (2 days only), Nov. 6 and 13.	
Woodcock	Nov. 1–Nov. 19.
Duck (except wood duck, ruddy duck, and buffehead), goose (except Ross's and snow geese and brant) coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $10.25. Alien, $15.25. Resident, $2.25. Issued by city and town clerks.

Bag and possession limits: 2 ruffed grouse or partridges, 3 cock pheasants (except 2 a day in towns of New Shoreham and Jamestown), 6 quail, 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, 4 woodcock, 15 Wilson's snipe, 15 coot, 15 rails, 25 in all of rails and gallinules a day, but not more than 15 of any one species of gallinules, and not more than 15 game birds of all kinds, of which not more than 8 may be wild geese or 12 woodcock, in possession at one time. Possession of waterfowl, coots, and gallinules permitted during first 10 days of close season.

Game taken outside of State and legally exported may be imported and possessed under permit from commissioners, except migratory game birds as above stated.

Interstate transportation: Export of all game prohibited; provided, a nonresident licensee may take out under his license 10 wild fowl (8 geese) or other birds in 1 calendar year if carried open to view.

SOUTH CAROLINA

Open seasons:[25]	*Dates inclusive*
Deer (male) (see exceptions)	Aug. 15–Jan. 1.
Exceptions: In Greenville, Pickens, and Oconee Counties (1 day only)	Jan. 1, 1934.
In Bamberg, Chester, Edgefield, Lexington, Richland, and Saluda Counties, and within 2 miles of Salkehatchie River in Allendale County	No open season.
Bear	No close season.
Raccoon, opossum, rabbit, squirrel (see exceptions)	Sept. 1–Mar. 1.
Exceptions: Raccoon, opossum, in Hampton County	Nov. 1–Feb. 1.
Raccoon, opossum, in Clarendon County	Oct. 1–Mar. 1.
Rabbit, in Abbeville, Laurens, and McCormick Counties	Nov. 30–Mar. 1.
Fox squirrel, in Oconee County (1 day only)	Jan. 1, 1934.
Squirrel:	
In Cherokee County	Nov. 30–Feb. 1.
In Richland County	Oct. 1–Mar. 1.
In York County	Nov. 1–Mar. 1.
Wild turkey gobbler, partridge (quail) (see exceptions)	Nov. 30–Mar. 1.
Exceptions: Wild turkey gobbler, partridge, in Cherokee County	Nov. 30–Feb. 1.
Wild turkey in Greenville County (1 day only)	Jan. 1, 1934.
Wild turkey in Edgefield County	No open season.
Partridge (quail), in Anderson County (1 day only)	Dec. 1, 1933.
Partridge (quail), in Chester, Chesterfield, Fairfield, Greenville, Lancaster, Pickens, and York Counties	Nov. 30–Feb. 1.
Partridge (quail), in Edgefield County	Nov. 30–Feb. 15.
Partridge (quail), in Spartanburg County (also 1 day—Nov. 30)	Dec. 20–Jan. 31.
Blackbird	Nov. 30–Mar. 1.
Dove	Sept. 1–Sept. 30, Nov. 20–Jan. 31.
Woodcock	Dec. 1–Dec. 31.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's and snow geese and brant), coot, Wilson's snipe or jacksnipe	Nov. 16–Jan. 15.
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $15.25. Resident, $3.10 (State), $1.10 (county of residence). Issued by county game warden and agents.

Bag and possession limits: 5 deer, 20 wild turkeys, a season; 15 squirrels, 15 quail (partridge), 2 turkeys, 18 doves, 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, 4 woodcock, 20 Wilson's snipe, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Not more than 2 days' bag limit of ducks and geese and not more than 12 woodcock may be possessed at any one time. Possession of migratory game birds permitted during first 10 days of close season. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all resident nonmigratory game taken in State prohibited, except that a landowner or licensee may export under shipping tag from chief game warden of State 1 day's bag limit of resident nonmigratory game a week, if not for sale. Unlawful for any transportation company to receive for shipment out of the State any deer or other resident nonmigratory game unless duly tagged. Under Federal regulations not more than 2 days' limit of migratory birds (3 days' limit of woodcock) may be taken or shipped out of the State in any 1 calendar week. All packages containing migratory birds must be marked to show actual contents and names and addresses of consignor and consignee. No game may be removed from the State for sale.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

SOUTH DAKOTA

Open seasons:	*Dates inclusive*
Deer (male, with 2 or more points to 1 antler), in Meade, Lawrence, Pennington, Custer, and Fall River Counties only	Nov. 1–Nov. 20.
Elk	Nov. 1–Nov. 20.
Rabbit, squirrel	No close season.
Grouse, west of the Missouri River (except in Lyman and Stanley Counties)	Sept. 21–Sept. 24[26]

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[25] *South Carolina:* In Newberry County, the open season for hunting all game is Nov. 30–Mar. 1.

[26] *South Dakota:* Grouse and pheasant may not be hunted before 12 o'clock noon.

Open seasons—Continued.	*Dates inclusive*
Male pheasant, east of the Missouri River (except in Brule County), and in Tripp and Gregory Counties west of the Missouri River	Oct. 10–Oct. 24,[26] Nov. 17–Dec. 1.
West of the Missouri River (except in Lyman, Stanley, Gregory, Tripp, and Lawrence Counties), and in parts of Custer and Pennington Counties	Oct. 21–Oct. 22.[26]
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 1–Nov. 30.
Rail and gallinule, other than coot	Sept. 16–Nov. 30.

Hunting licenses: Nonresident or alien, big game, $25; small game, $25. Resident, big game, $5; small game, $1. Special license, small game, $3 (authorizes shipment of 50 birds in State as specified in license). Issued by game and fish department and deputies, and county treasurers.

Bag and possession limits: 1 deer, 1 elk, a year Not more than 15 game birds may be taken in any one day, of which not more than 4 may be grouse, 5 may be pheasants. Four geese, including brant, and 12 ducks may be taken in one day, but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall; 25 coot a day or in possession; 20 jacksnipe a day or in possession. Possession permitted for 5 days after close of season, but not more than 30 birds (2 days' limit of grouse and pheasant, and 2 days' limit of ducks and geese, including brant) may be possessed at one time. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game prohibited; provided, a nonresident may, under permit of the game and fish commission, export 1 deer lawfully killed, and not more than 5 upland nonmigratory birds under each of 5 of the coupons, and not more than 5 migratory game birds under each of 5 of the coupons attached to his nonresident license; but not more than 8 geese, including brant, may be exported by one person in any one calendar week, and if exported by common carrier or as personal baggage tags attached to hunting license must be affixed to each shipment.

TENNESSEE

Open seasons:	*Dates inclusive*
Deer (male) (see exception)	Dec. 1–Dec. 10.
Exception: In Cheatham, Lewis, Perry, and Wayne Counties	No open season.
Rabbit (see exceptions)	Nov. 25–Jan. 31.
Exceptions: In Sullivan County	Nov. 15–Jan. 1.
In Cannon, Dickson, Hickman, and Houston Counties	No close season.
Squirrel (see exceptions)	June 1–Dec. 31.
Exceptions: In Dyer County	July 1–Dec. 31.
In Johnson County	July 1–Dec. 1.
In Cannon County	No close season.
Quail, wild turkey (see exceptions)	Nov. 25–Jan. 31.
Exceptions: Quail in Johnson County	Nov. 1–Jan. 1.
Quail in Sullivan County	Nov. 15–Jan. 1.
Quail in Cocke County	No open season.
Wild turkey in Lewis County	No open season.
Pheasant (see exception)	No open season.
Exception: In Johnson County	Nov. 1–Jan. 1.
Dove	Sept. 1–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Nov. 16–Jan. 15.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.
Gallinule	Nov 1–Nov. 30.

Hunting licenses: Nonresident, $15 (may hunt on own land without license). Resident, State, $2. Issued by county clerks. *Reelfoot Lake:* Guide or pusher, $1; issued to residents only.

Bag and possession limits: 2 deer, 3 wild turkeys, a season; 10 squirrel, 15 quail, and 15 of other game birds a day, but not more than 4 geese including brant, 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 15 of any one species of rails (other than sora) and gallinules, a day. Not more than 2 days' bag limit of ducks and geese may be possessed at one time.

Reelfoot Lake: 12 ducks (see exception above as to ducks), 4 geese including brant, 20 Wilson's snipe, 20 in all of rails, coot, and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, a day, but not more than 20 in all of game birds a day.

Game taken outside of State and lawfully exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game prohibited; provided, nonresident licensee may take out of State, if carried openly, game birds legally killed by him (except that 25 birds only may be exported from Reelfoot Lake), but not more than 2 days' limit of ducks and geese, including brant, 40 Wilson's snipe, 50 coots, 50 sora, 50 in all of rails and gallinules, but not more than 30 of any one species of rails (other than sora) and gallinules, and 36 doves may be exported by one person in any 1 calendar week.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

TEXAS

Open seasons:	*Dates inclusive*
Deer[27] (male, with pronged horn) (see exceptions), bear	Nov. 16–Dec. 31.
Exceptions: Black-tailed deer (male) west of Pecos River	Nov. 16–Nov. 30.
Deer, in Anderson, Archer, Bastrop, Bowie, Brown, Burnet (north of Colorado River), Callahan, Camp, Cass, Clay, Coleman, Coryell, Eastland, Freestone, Galveston, Haskell, Hamilton, Harrison, Hempbill, Henderson, Hutchinson, Jack, Jasper, Jones, Lamar, Lampasas, Leon, Limestone, Marion, Montague, Morris, Navarro, Newton, Palo Pinto, Panola, Parker, Red River, Roberts, Sabine, San Augustine, San Saba, Shackelford, Stephens, Throckmorton, Titus, Upshur, Wise, Wood, and Young Counties	No open season.
Squirrel (see exceptions)	May 1–July 31, Oct. 1–Dec. 31.
Exceptions: In Polk, Trinity, Nacogdoches, and Shelby Counties	Nov. 1–Jan. 31.
In Jefferson County	June 1–July 31, Nov. 1–Jan. 31.
In Jasper and Newton Counties	Dec. 1–Jan. 16.
In Hardin and Liberty Counties	June 1–June 30, Nov. 16–Jan. 16.
In Sabine and San Augustine Counties	Nov. 1–Dec. 31.
In Angelina and Tyler Counties	July 1–July 31, Oct. 1–Dec. 31.
In Panola County	July 1–July 31, Nov. 1–Dec. 31.

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[26] See page 27.

[27] *Texas:* Unlawful to kill deer having less than 8-point antlers in Frio, La Salle, Live Oak, and McMullen Counties.

Open seasons—Continued.	*Dates inclusive*
Squirrel—Continued.	
Exceptions—Continued.	
In Austin, Bandera, Bastrop, Blanco, Bosque, Brazoria, Brown, Burnet, Caldwell, Callahan, Colorado, Comal, Comanche, Cooke, Coryell, DeWitt, Dimmit, Eastland, Edwards, Erath, Fayette, Fort Bend, Gillespie, Goliad, Gonzales, Guadalupe, Hamilton, Hays, Hill, Jackson, Karnes, Kendall, Kerr, Kimball, Lampasas, Lavaca, Llano, Mason, Matagorda, McCulloch, Medina, Menard, Mills, Montague, Parker, Real, San Saba, Schleicher, Stephens, Tarrant, Throckmorton, Travis, Uvalde, Victoria, Waller, Washington, Wharton, Wilson, Wise, Young, and Zavala Counties	No close season.
Quail or partridge, chachalaca or Mexican pheasant (see exceptions)	Dec. 1–Jan. 16.
Exceptions: In Panola, Rusk, and Harrison Counties	Dec. 1–Jan. 31.
Quail, in Anderson, Andrews, Archer, Borden, Glasscock, Howard, Stephens, and Yoakum Counties, and part of Karnes County	No open season.
Prairie chicken or pinnated grouse (see exception)	Sept. 1–Sept. 4.
Exception: In Collingsworth and Wheeler Counties	No open season.
Wild turkey gobblers (see exceptions)	Nov. 16–Dec. 31.
Exceptions: In Angelina, Bastrop, Brazos, Burleson, Cherokee, Grimes, Harris, Houston, Jasper, Lee, Leon, Madison, Montgomery, Nacogdoches, Newton, Polk, Robertson, Sabine, San Augustine, San Jacinto, Trinity, Tyler, Walker, and Washington Counties	Mar. 1–Apr. 30.
In Bowie, Callahan, Camp, Cass, Comal, Eastland, Freestone, Guadalupe, Harrison, Lamar, Lampasas, Leon, Limestone, Marion, Morris, Palo Pinto, Panola, Red River, San Saba, Shackelford, Stephens, Titus, Upshur, and Wood Counties, and in Burnet County north of Colorado River	No open season.
Mourning dove, in north zone (except in Howard County, no open season)	Sept. 1–Oct. 31.[28]
In south zone	Oct. 1–Nov. 30.[28]

Open seasons—Continued.	*Dates inclusive*
White-winged dove, in north zone	Aug. 8–Oct. 31.[29]
In south zone	Aug. 20–Oct. 31.[29]
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe, in north zone [28]	Nov.1–Dec.31.[28] [30]
In south zone [28]	Nov. 16–Jan. 15.
Rail, other than coot and gallinule	Sept. 1–Oct. 31.
Gallinule, in north zone [28]	Oct. 16–Nov. 30.
In south zone [28]	Nov. 1–Nov. 30.

Hunting licenses: Nonresident or alien, $25; nonresident 5-day license, $1.10. Resident citizen, $2 (not required in county of residence). Issued by commission, deputies, and county clerks. Boat (carrying hunters), $2; club or shooting preserve, $5. Issued by commission.

Bag and possession limits: 2 deer (west of Pecos River, 1 blacktail), 1 bear. 3 turkey gobblers a season; 10 squirrels a day; 12 in all of quail and chachalacas a day, 36 in 7 days, 36 of each in possession; in Wood County, 8 a day, 24 in 7 days; 10 prairie chickens a day or season; 15 doves and white-wings a day, 45 in 7 days or in possession; in Wood County, 10 a day, 40 in 7 days; 25 in all of ducks, rails, coots, gallinules, a day, but not more than 12 ducks a day (8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shovler, and gadwall) nor more than 15 of any one species of rails (other than sora), and gallinules, a day, 50 in all in 7 days; 4 geese and brant combined a day, 12 in 7 days; 20 jacksnipe a day. Not more than two days' bag limit of ducks and geese, including brant, may be possessed at any one time. Possession of all game permitted during open season and 10 days immediately following. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export prohibited of all game, except that nonreisdent licensee may ship game lawfully possessed to his home for own use under affidavit (fee, 25 cents), that it was lawfully killed and will not be bartered or sold; provided that not more than 2 days' limit of migratory birds may be exported in any 1 calendar week. Game may be shipped to taxidermist for mounting under affidavit that shipper killed the specimen and that it is not being preserved for sale.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

UTAH

Open seasons:[31]	*Dates inclusive*
Deer (male, with horns not less than 5 inches long)	Oct. 20–Oct. 30.
Elk	Nov. 8–Nov. 22.
Bear, rabbit, hare	No close season.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.

Hunting licenses: Nonresident citizen—deer and bear, $15; elk, $50; small game and fish, $10. Resident citizen—male, 12 to 16 years old, game and fish, $1; over 16 years, $3; game, $2; females, 16 and over, game and fish, $1; elk, $10. Guide, $5 (resident only). Issued by commissioner or deputy, county clerk or deputy, and authorized agents. Alien not permitted to hunt or own firearms.

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[28] North and south zones divided by line running approximately northeast from Rio Grande near Del Rio, following Southern Pacific R.R. to San Antonio; International & Great Northern R.R. to Austin; Houston & Texas Central R.R. to Brazos River; Brazos River to Beaumont Branch of Santa Fe Ry.; Gulf, Colorado & Santa Fe R.R. to Cleveland, and Houston East & West Texas R.R. to Louisiana line.

[29] Zones for white-winged doves are divided by Texas-Mexican Ry. from Laredo to Corpus Christi.

[30] Waterfowl may not be hunted or killed after 12 o'clock noon in Harrison and Marion Counties.

[31] *Utah:* Commissioner may fix open seasons and bag limits on upland game birds, and on mourning doves not to exceed season and bag limit fixed by Federal regulation.

Bag and possession limits: 1 male deer a season; 25 in the aggregate of ducks, geese (including brant), coots, and Wilson's snipe a day, but not more than 12 ducks (8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese (including brant), 25 coots, or 15 Wilson's snipe a day, Not more than 2 days' bag limit of migratory game birds may be possessed at one time.

Game taken outside of State and legally exported may be possessed at any time, but migratory game birds may be possessed only during open season and first 10 days of close season. Persons possessing game during close season must show lawful taking.

Interstate transportation: Export of all game prohibited except under permit and regulations of commissioner.

VERMONT

Open seasons:	*Dates inclusive*
Deer (with horns not less than 3 inches long) (see exception)	Nov. 21–Nov. 30.
Exception: In Essex County	Nov. 1–Nov. 30.
Hare, rabbit	Oct. 1–Feb. 28.
Gray squirrel, woodcock, ruffed grouse	Oct. 1–Oct. 31.
Pheasant (8 days)	Oct. 4, 7, 11, 14, 18, 21, 25, 28.
Quail	Sept. 15–Nov. 30.
Duck (except wood duck, ruddy duck, and bufflehead) (see exception), goose (except Ross's goose and brant) coot, English or Wilson's snipe (jacksnipe), gallinule	Oct. 1–Nov. 30.
Exception: Ducks on waters or shores of Joes Pond in towns of Danville, Cabot, and Walden, Stone Pond or Shadow Lake in town of Glover, Caspian Lake in town of Greensboro, and Groton or Lunds Pond in town of Groton (1937)	No open season.

Hunting licenses: Nonresident: Game, $10.50; but residents of States or countries charging larger nonresident angling license fee must pay fee charged nonresidents in own State or country. Resident: Game and fish, $1.50; game, $1. Issued by town clerks. Citizen of United States who owns $1,000 taxable property in Vermont pays same fees as resident. Alien resident who has not declared his intention pays same fees as nonresident; declarant resident for six months in State pays same fees as resident.

Bag and possession limits: 1 deer a season; 4 ruffed grouse a day, 25 a season; 4 woodcock a day, 25 a season, 12 in possession; 2 pheasants a day, 4 a season; 5 hares or rabbits a day or in possession; 4 gray squirrels a day or in possession; 4 quails a day, 10 ducks a day, 40 a season, but not more than 8 a day of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall; 5 geese a season but not more than 4 a day; 10 Wilson's snipe a day; 25 coots; 25 gallinules, but not more than 15 gallinules of any one species, a day.

Possession of waterfowl, coots, and gallinules permitted during first 10 days of close season, but not more than 24 ducks (16 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), and 5 geese may be possessed at any one time.

Game taken outside of State and legally exported may be possessed as authorized by permit obtained from fish and game commissioner, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Interstate transportation: Export prohibited of all protected game, except hares and rabbits; provided, a nonresident licensee may export one deer under license coupon and 1 day's bag limit of game birds under permit, but must accompany shipment; resident may export (if not for sale) 1 day's bag limit of game birds under special permit from commissioner and one deer a season for sale, if it is tagged and license is presented to carrier for cancelation, but laws of State to which deer is shipped must be complied with. Packages containing game delivered to a common carrier for transportation must be tagged to show number and kind of such game therein, names of consignor and consignee, station from which shipped, destination, and number of license. License of shipper must be presented to agent of transportation company for indorsement thereon of quantity of game offered for transportation. Heads, hides, feet, and fur of quadrupeds and plumage and skins of game birds legally killed and possessed may be transported without tags if accompanied by owner.

VIRGINIA

Open seasons:	*Dates inclusive*
Deer (male, with horns visible above hair) east of Blue Ridge Mountains (see exceptions)	Nov. 15–Dec. 31.
Exceptions: In Nansemond and Norfolk Counties	Oct. 1–Nov. 30.
In Accomac, Albemarle, Amherst, Arlington, Bedford, Campbell, Culpeper, Elizabeth City, Essex, Fairfax, Fauquier, Franklin, Gloucester, Greene, Henry, King George, Lancaster, Loudoun, Mathews, Madison, Middlesex, Nelson, Northampton, Northumberland, Orange, Patrick, Prince William, Princess Anne, Rappahannock, Richmond, Spottsylvania, Stafford, Warwick, Westmoreland, and York Counties	No open season.
West of Blue Ridge Mountains (see exceptions)	Nov. 15–Nov. 30.
Exceptions: In Alleghany and Bath Counties	Nov. 15–Nov. 20.
In Augusta, Bland, Botetourt, Buchanan, Carroll, Clarke, Dickenson, Floyd, Frederick, Giles, Grayson, Highland, Lee, Montgomery, Page, Pulaski, Roanoke, Rockbridge, Rockingham, Russell, Scott, Shenandoah, Smyth, Tazewell, Warren, Washington, Wise, and Wythe Counties	No open season.
Elk (with horns visible above hair) (see exception)	Dec. 15–Dec. 31.
Exception: Bull elk, in Bland, Craig, Giles, Montgomery, and Pulaski Counties (3 days)	Dec. 1, 2, 4.
Black bear (adult), east of Blue Ridge Mountains (see exception)	Nov. 15–Jan. 31.
Exception: In Nansemond and Norfolk Counties	Oct. 1–Nov. 30.
West of Blue Ridge Mountains	Nov. 15–Dec. 31.
Rabbit (see exception)	Nov. 15–Jan. 31.
Exception: In Accomac, Culpeper, Fairfax, Fauquier, Franklin, Loudoun, Northampton, Orange, Prince William, and Rappahannock Counties, and west of Blue Ridge Mountains	Nov. 15–Dec. 31,

Open seasons—Continued.	*Dates inclusive*
Squirrel (see exceptions)	Sept. 1–Jan. 31.
Exceptions: In Albemarle, Amelia, Amherst, Arlington, Bedford, Brunswick, Campbell, Charles City, Charlotte, Cumberland, Dinwiddie, Elizabeth City, Essex, Fluvanna, Franklin, Goochland, Greene, Greensville, Halifax, Hanover, Henry, James City, King and Queen, King William, Lancaster, Lunenburg, Madison, Mathews, Mecklenburg, Middlesex, Nelson, New Kent, Northumberland, Nottoway, Patrick, Pittsylvania, Powhatan, Prince George, Richmond, Spotsylvania, Stafford, Warwick, Westmoreland, and York Counties	Sept. 1–Sept. 30, Nov. 15–Jan. 31.
In Augusta, Bland, Botetourt, Carroll, Clarke, Craig, Dickenson, Floyd, Giles, Grayson, Lee, Montgomery, Page, Pulaski, Roanoke, Rockbridge, Rockingham, Russell, Scott, Smyth, Tazewell, Warren, Washington, Wise, and Wythe Counties	Sept. 1–Dec. 31.
In Alleghany County	Sept. 1–Sept. 10, Nov. 15–Dec. 15.
In Appomattox, Buckingham, Chesterfield, Culpeper, Gloucester, Louisa, and Prince Edward Counties	Nov. 15–Jan. 31.
In Bath and Highland Counties	Sept. 1–Sept. 10, Nov. 15–Nov. 30.
In Frederick County	Sept. 1–Oct. 15, Nov. 15–Dec. 31.
In Accomac and Northampton Counties	Oct. 1–Dec. 31.
In Fairfax, Fauquier, Loudoun, Orange, Prince William, and Rappahannock Counties	Sept. 1–Sept. 30, Nov. 15–Dec. 31.
In Isle of Wight, Nansemond, Norfolk, and Princess Anne Counties	Oct. 1–Jan. 31.
In Shenandoah County	Sept. 1–Sept. 15, Nov. 15–Dec. 31.
Wild turkey, ruffed grouse, bobwhite quail, east of Blue Ridge Mountains (see exceptions)	Nov. 15–Jan. 31.
Exceptions: In Accomac, Culpeper, Fairfax, Fauquier, Greene, Loudoun, Northampton, Orange, Prince William, and Rappahannock Counties	Nov. 15–Dec. 31.
Turkey, in Albermarle County	Nov. 15–Nov. 30.
Turkey, in Essex, Lancaster, Northumberland, Richmond, and Westmoreland Counties	Nov. 15–Dec. 15.
Turkey, in Franklin and Henry Counties	No open season.
West of Blue Ridge Mountains (see exceptions)	Nov. 15–Dec. 31.
Exceptions: Turkey, in Bland, Buchanan, Carroll, Dickenson, Floyd, Giles, Grayson, Henry, Lee, Montgomery, Patrick, Pulaski, Roanoke,	
Open seasons—Continued.	*Dates inclusive*
Wild turkey, ruffed grouse, bobwhite quail—Contd.	
West of Blue Ridge Mountains—Continued.	
Exceptions—Continued.	
Russell, Scott, Smyth, Tazewell, Washington, Wise, and Wythe Counties	No open season.
Turkey, ruffed grouse, in Alleghany County	Nov. 15–Dec. 15.
Turkey, ruffed grouse, in Bath and Highland Counties	Nov. 15–Nov. 30.
Quail, in Alleghany, Bath, and Highland Counties	Nov. 15–Dec. 15.
Quail, in Franklin County	Nov. 15–Dec. 31.
Ringneck pheasant (see exceptions)	Nov. 15–Dec. 31.
Exceptions: In Charlotte County	Nov. 15–Jan. 31.
In Augusta County (male only)	Nov. 15–Nov. 24.
In Bedford County	No open season.
Mourning dove	Sept. 1–Dec. 15.
Woodcock	Nov. 15–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross' and snow geese and brant), coot, Wilson's snipe or jacksnipe	Nov. 16–Jan. 15.[32]
Rails and gallinules (other than coot)	Sept. 1–Nov. 30.

Hunting licenses: Nonresident (combined hunting, fishing, and trapping), $15.50. Additional county certificates required for bull elk in Bland, Craig, Giles Montgomery, and Pulaski Counties. Non-resident, $2.50; resident, 50 cents. Alien, hunting, $15.50. Resident: Statewide, $3; county, $1. Licenses issued by clerks of circuit and corporation courts and designated agents. Commissioned and listed personnel of Army, Navy, and Marine Corps stationed in Virginia, pay same fees for hunting as residents.

Special licenses, Back Bay, Princess Anne County: Battery, sinkbox, mat blind,[32] fee $100 (limited to not more than 50 batteries and sinkboxes and 27 mat blinds actually used in 1927–28; any license not renewed each year may not be reissued until number of batteries and sinkboxes is less than 25 and that of mat blinds less than 11). Shore blind, $50. Issued by clerk, circuit court, Princess Anne County.

Bag and possession limits: 1 elk a season; 1 deer a day, 2 a season (in Alleghany, Bath, Craig, and Highland Counties, 1 a season); 10 each of squirrels and rabbits a day, 150 of each a season; 2 turkeys a day, 4 a season (2 a season in Rockbridge County); 4 grouse a day, 16 a season; 15 quail a day, 150 a season; 4 ringneck pheasants a day, 20 a season (in Augusta County 2 a day, 4 a season); 18 doves a day, 250 a season; 4 woodcock a day, 25 a season; 12 ducks a day (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 350 a season; 4 geese a day, 50 a season; 20 Wilson's snipe a day, 250 a season; 25 sora a day, 500 a season; 25 coots a day, 250 a season; 25 in all of rails and gallinules (other than sora) a day, but not more than 15 of any one species, 250 a season.

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[32] *Virginia:* Wild fowl may not be hunted on Wednesdays or Saturdays on Back Bay in Princess Anne County, nor on Wednesdays elsewhere east of the Blue Ridge Mountains except in Accomac and Northampton Counties.

Battery, sinkbox, mat blind, or other floating device, or any boat or tender thereof, may not anchor, tie-out, or lie within 700 yards (except in North Bay, 200 yards) of any licensed blind or any blind on shore not licensed that is at any time occupied by the owner, or member or guest of any club owning same, for shooting therefrom.

Possession permitted during first 10 days of close season, but not more than 2 days' bag limit of ducks and geese and not more than 12 woodcock may be possessed at one time.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Interstate transportation: Export of all protected game (except rabbits and squirrels) prohibited; provided, during open season any licensee may, under his hunting license, take with him out of State, or as baggage on same conveyance, open to view, and plainly labeled with his name and address, not more than 2 days' limit of game lawfully taken by him. Any citizen of State may ship from State during open season as a gift and not for sale (which fact must be stated on shipping tag) 1 day's bag limit in 1 calendar week, if open to view and plainly labeled with names and addresses of donor and donee and number and kind of each so shipped.

Miscellaneous: Doves may not be shot within 100 yards of any area where grain or other food has been placed or scattered to attract them.

WASHINGTON

Open seasons:	*Dates inclusive*
Deer (male, with branched antlers), in Clallam, Jefferson, Mason, Grays Harbor, Thurston, Pierce, Pacific, Lewis, Wahkiakum, Cowlitz, Clark, Skamania, King, Snohomish, Skagit, Whatcom, and Kitsap Counties, and Klickitat County west of White Salmon River	Oct. 1–Oct. 15.
In Chelan, Kittitas, Okanogan, Ferry, Stevens, Pend Oreille, and Spokane Counties	Oct. 22–Nov. 4.
In Asotin, Columbia, Garfield, Walla Walla Counties, and rest of Klickitat County	Oct. 15–Oct. 31.
In Adams, Benton, Douglas, Franklin, Grant, Lincoln, Whitman, Yakima, Island, and San Juan Counties	No open season.
Bull elk, in Asotin, Columbia, Garfield, Kittitas, Walla Walla, and Yakima Counties	Nov. 5–Nov. 19.
In Clallam, Jefferson, Grays Harbor, and Mason Counties	Oct. 19–Oct. 22.
In rest of State	No open season.
Bear, in Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, King, Kitsap, Lewis, Mason, Pacific, Pierce, Skagit, Skamania, Snohomish, Thurston, Wahkiakum, and Whatcom Counties, and Klickitat County west of White Salmon River	Oct. 1–Oct. 15.
In rest of Klickitat County	Oct. 15–Oct. 31.
In Yakima County	Nov. 5–Nov. 10.
In Chelan, Kittitas, Okanogan, Ferry, Stevens, and Pend Oreille Counties	Oct. 22–Nov. 4.
In rest of State	No open season.
Cottontail rabbit (see exception)	Oct. 22, 25, 28, 29, 30; Nov. 5.
Exception: In Island and San Juan Counties	Oct. 22, 25, 28, 29, 30, Nov. 1–30.
Snowshoe rabbit (see exceptions)	No open season.
Exceptions: In Asotin, Columbia, Garfield, and Walla Walla Counties	Oct. 15–Oct. 31, Nov. 5–Nov. 10.
In Chelan, Okanogan, Pend Oreille, Spokane, and Stevens Counties	Oct. 29–Nov. 12.
Open seasons—Continued. Snowshoe rabbit—Continued. *Exceptions*—Continued.	*Dates inclusive*
In Kittitas County	Oct. 22–Nov. 10.
In Klickitat County, east of White Salmon River	Oct. 15–Oct. 31.
In Yakima County	Nov. 5–Nov. 10.
Valley quail, in Benton, Okanogan, Chelan, Kittitas, Yakima, and Island Counties only	Oct. 22, 25, 28, 29, 30.
Blue grouse, in Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, King, Kitsap, Lewis, Mason, Pacific, Pierce, Skagit, Skamania, Snohomish, Thurston, Wahkiakum, Whatcom, Chelan, Stevens, Ferry, Pend Oreille, and Okanogan Counties only	Oct. 22, 25, 28, 29, 30.
Chinese pheasant (see exception)	Oct. 22, 25, 28, 29, 30, Nov. 5.
Exception: In Island County	No open season.
Hungarian partridge, in Adams, Asotin, Benton, Columbia, Douglas, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Spokane, Walla Walla, Whitman, and Yakima Counties only	Oct. 22, 25, 28, 29, 30, Nov. 5.
Band-tailed pigeon	Oct. 16–Oct. 30.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, and Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.[33]
Rails, other than coot	Oct. 1–Nov. 30.

Hunting licenses: Nonresident citizen or declarant residing in State less than 6 months: State, $25 (applicant from adjoining State pays same fee charged by his State to resident of Washington); game birds, $15. Resident: State, $7.50; county, $1.50. Guide, $10. Resident special elk license (fee $5), issued to holder of State or county license; nonresident, $25, issued to holder of State license. Alien, hunting and fishing, $25 (issued only to holder of permit to carry firearms). Licenses issued by county auditors.

Bag and possession limits: 1 deer, 1 elk, a season; 5 cottontail, 2 snowshoe rabbits a day; 3 blue grouse, 3 Chinese or Mongolian pheasants, 5 each of quail and Hungarian partridges a day; a person desiring to possess more than one day's limit of upland game birds may do so by having each day's kill tagged that day by a game warden, and such tagged birds may be possessed during close season. Tagging fee, 10 cents for each bird, animal, or fish; 10 band-tailed pigeons a day or in possession; 20 ducks, geese, brant, Wilson's snipe a week (week ends at midnight Saturday), but not more than 4 geese, including brant, or 12 ducks a day (but not more than 5 eider ducks, nor more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall); 25 coots, 25 sora, and 25 in all of other rails (except sora), but not more than 15 of any one species of rails (except sora) a day. Not more than two days' bag limit of wild ducks and wild geese including brant may be possessed at one time.

Possession during close season permitted upon filing with commission description and number of each kind of game, which must be tagged or stamped by commission for identification, but rails may only be possessed until December 10, and other migratory game birds for 10 days after close of open season.

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[33] *Washington:* Season on migratory game birds, except band-tailed pigeons, opens at 12 o'clock noon. No open season on waterfowl on Columbia or Snake Rivers or within a quarter of a mile of their shores in Benton, Columbia, Douglas, Franklin, Garfield, Grant, Kittitas, Klickitat, Walla Walla, Whitman, and Yakima Counties.

Game taken outside of State when accompanied by affidavit of chief game official may be possessed at any time for noncommercial use, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Interstate transportation: Export of all protected game prohibited, except that nonresident licensee may carry with him one day's limit of game birds upon attaching an affidavit that they were lawfully killed by himself and are not being exported for sale.

WEST VIRGINIA

Open seasons:	*Dates inclusive*
Deer (male, with branched horns), in Grant, Greenbrier, Hampshire, Hardy, Mineral, Monongalia, Morgan, Nicholas, Pocahontas, Preston, Randolph, Tucker, and Webster Counties only	Nov .2–Nov. 11.
Rabbit, varying hare	Nov. 1–Dec. 31.
Squirrel (see exceptions)	Sept. 16–Oct. 31.
Exceptions: In Jefferson, Berkeley, Morgan, Mineral, Hardy, Grant, Pendleton, Hampshire, Preston, Monongalia, Lewis, Marion, Harrison, and Taylor Counties	Sept. 16–Sept. 30, Oct. 16–Nov. 15.
In Greenbrier, Nicholas, Webster, Pocahontas, Randolph, Upshur, Barbour, and Tucker Counties	Oct. 16–Nov. 30.
Raccoon, opossum	Nov. 1–Jan. 31.
Wild turkey, ruffed grouse (pheasant) (see exception)	Oct. 16–Nov. 30.
Exception: Wild turkey in Hancock, Brooke, Ohio, Marshall, Wetzel, Tyler, Pleasants, Wood, Ritchie, Wirt, Marion, Harrison, Calhoun, Lewis, Gilmer, Roane, Jackson, Mason, Cabell, Putnam, Kanawha, Wayne, and Lincoln Counties	No open season.
Quail	Nov. 15–Dec. 31.
Woodcock	Nov. 15–Dec. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 16–Dec. 15.
Rail and gallinule, other than coot	Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $15; resident, State, $3; county of residence and adjoining counties, $1. Issued by county clerk. Aliens not permitted to hunt or possess firearms.

Bag and possession limits: 1 deer a season; 1 wild turkey a day, 1 a season; 6 rabbits a day, 40 a season, except rabbits killed on own premises; 2 varying hares a day, 10 a season; 5 squirrels a day, 30 a season; 8 quails a day, 48 a season; 3 ruffed grouse a day, 12 a season; 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall); 4 geese, including brant; 4 woodcock a day, 12 in possession; 20 Wilson's snipe; 25 coots; 25 sora; and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Not more than 2 days' limit of ducks and geese, including brant, may be possessed at any one time. Possession of migratory birds permitted during first 10 days of close season; other game legally taken may be possessed at any time.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during the open season where taken and first 10 days of close season.

Interstate transportation: Export prohibited of elk, deer, squirrels, quail, ruffed grouse (pheasant), wild turkeys, geese, brant, ducks, provided, a nonresident licensee may personally take with him out of the State, during any open season, one day's limit of game animals or birds lawfully taken by himself.

WISCONSIN

Open seasons:	*Dates inclusive*
Deer, bear	No open season.
Raccoon	Nov. 1–Dec. 31.
Rabbit (see exceptions)	Oct. 28–Jan. 15.
Exceptions: In Ashland, Barron, Bayfield, Burnett, Douglas, Polk, Price, Rusk, Sawyer, Washburn, Chippewa, Dunn, Eau Claire, Florence, Forest, Iron, Langlade, Lincoln, Marathon, Marinette, Oconto, Oneida, Pierce, Shawano, St. Croix, Taylor, and Vilas Counties	Sept. 30–Feb. 15.
In Milwaukee County	No open season.
Squirrel (see exception)	Nov. 1–Jan. 1.
Exception: In Dodge, Fond du Lac, Jefferson, Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties	No open season.
Ruffed grouse (partridge), prairie chicken (pinnated grouse), sharp-tailed grouse, in Ashland, Barron, Bayfield, Burnett, Douglas, Florence, Forest, Iron, Langlade, Lincoln, Marinette, Oconto, Oneida, Polk, Price, Rusk, Sawyer, Taylor, Vilas, and Washburn Counties	Sept. 30–Oct. 12.
Ruffed grouse (partridge), in Adams, Buffalo, Chippewa, Clark, Columbia, Crawford, Door, Dunn, Eau Claire, Green Lake, Jackson, Juneau, Kewaunee, LaCrosse, Manitowoc, Marathon, Marquette, Monroe, Outagamie, Pepin, Pierce, Portage, Rich land, St. Croix, Sauk, Sha wano, Sheboygan, Trem pealeau, Vernon, Washington, Waupaca, Waushara, and Wood Counties	Sept. 30–Oct. 8.
In rest of State	No open season.
Prairie chicken (pinnated grouse), sharp-tailed grouse, in Adams, Chippewa, Clark, Columbia, Dunn, Eau Claire, Green Lake, Jackson, Juneau, Marathon, Marquette, Monroe, Outagamie, Pierce, Portage, St. Croix, Sauk, Shawano, Trempealeau, Waupaca, Waushara, and Wood Counties	Sept. 30–Oct. 8.
In Dane County	Sept. 30–Oct. 4.
In rest of State	No open season.
Bobwhite quail, in Crawford, Jackson, Juneau, LaCrosse, Monroe, Richland, Sauk, Trempealeau, and Vernon Counties only	Sept. 30–Oct. 4.
Hungarian partridge, in Kenosha, Walworth, and Racine Counties only	Sept. 30–Oct. 4.
Pheasant (male), in Columbia, Dodge, Fond du Lac, Green Lake, Marquette, Sauk, Sheboygan, Washington, Waushara, and part of Juneau and Winnebago Counties	Sept. 30–Oct. 2.

Open seasons—Continued.	*Dates inclusive*
Pheasant (male)—Continued.	
In Barron, Buffalo, Burnett, Chippewa, Dane, Dunn, Eau Claire, Green, Jefferson, Kenosha, Pepin, Pierce, Polk, Racine, Rock, St. Croix, Trempealeau, Walworth, Washburn, Waukesha, and part of Iowa and Lafayette Counties	Sept. 30–Oct. 4.
In rest of State	No open season.
Woodcock	Sept. 30–Oct. 15.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe, rails, and gallinules	Sept. 21–Nov. 20.[34]

Hunting licenses: Nonresident, all game, $50; all game except deer, $25; 3 shipping coupons, $2 additional. Settler, hunting deer, $1 (deer tag $1); guide, $1. Issued by commission. Resident, $1 (deer tag $1 additional); issued by county clerks.

Bag and possession limits: [35]1 male deer in even years; 5 squirrels, 5 rabbits, a day (except rabbits in Crawford County, no limit); 4 ruffed grouse, 4 prairie chickens, 4 sharp-tailed grouse, 4 Hungarian partridges, 4 bobwhite quail, a day, 8 of each in possession; 2 male pheasants a day, 4 in possession; 4 woodcock a day, 12 in possession; 4 geese, including brant, a day; 12 ducks (including coot, or mud hen) a day, but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall; Wilson's snipe, rails, rice hens (gallinules), 15 a day, but not more than 25 in all of rails and gallinules a day. Possession of tagged deer permitted at any time for personal use, but not more than one day's bag limit of game, except as above stated, may be possessed at one time, and possession of game by an unlicensed person or one not holding a scientific permit, prohibited at all times.

Game taken outside of State and legally exported may be possessed as authorized by permit from conservation commission, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Interstate transportation: Export of all protected game prohibited, except that nonresident licensee may transport, between November 21 and November 30, inclusive (1934), 1 deer duly tagged, if he accompanies shipment and may take in his personal possession, openly, a mixed bag of not more than 20 game birds legally killed, but not more than the bag limit for one day of any one variety.

WYOMING

Open seasons:	*Dates inclusive*
Deer (male, with forked horns), in Park and Teton Counties	Sept. 15–Nov. 15.
In Albany, Big Horn, Campbell, Carbon, Converse, Johnson, Lincoln, Natrona, Platte, Sheridan, and Uinta Counties	Oct. 15–Oct. 31.
In Fremont County	Oct. 1–Oct. 31.
In Sweetwater County	Oct. 15–Oct. 22.
In Washakie County	Oct. 15–Oct. 19.
In Sublette County	Oct. 1–Nov. 15.
In Crook and Weston Counties	Oct. 15–Nov. 15.
In Goshen, Hot Springs, Laramie, and Niobrara Counties	No open season.
Elk, in Albany, Big Horn, and Sheridan Counties	Oct. 15–Oct. 31.
In Fremont, Park, and Teton Counties	Sept. 15–Nov. 15.
In Lincoln and Sublette Counties	Oct. 1–Nov. 15.
In rest of State	No open season.

Open seasons—Continued.	*Dates inclusive*
Bull moose, in Fremont, Park, and Teton Counties	Sept. 15–Nov. 15.[36]
In Lincoln and Sublette Counties	Oct. 1–Nov. 5.[36]
In rest of State	No open season.
Antelope, in Campbell and Park Counties only	Sept. 5–Oct. 5.[36]
Mountain sheep (male), in Fremont and Park Counties	Sept. 15–Nov. 15.
In Lincoln, Sublette, and Teton Counties	Oct. 15–Oct. 31.
In rest of State	No open season.
Sage hen or sage chicken (see exception)	Aug. 6–Aug. 13.
Exception: In Fremont, Goshen, Laramie, and Platte Counties	No open season.
Grouse, in Campbell, Crook, Fremont, Lincoln, Sublette Sweetwater, Teton, Uinta, and Weston Counties	Sept. 1–Oct. 1.
In Johnson and Sheridan Counties	Sept. 15–Oct. 1.
In Park County	Sept. 15–Nov. 15.
In rest of State	No open season.
Pheasant (see exception)	No open season.
Exception: In Big Horn, Fremont, Goshen, Hot Springs, Park, Platte, Sheridan, and Washakie Counties	Nov. 11–Nov. 13.
Duck (except wood duck, ruddy duck, and bufflehead), goose (except Ross's goose), brant, coot, Wilson's snipe or jacksnipe	Oct. 1–Nov. 30.
Rails and gallinules (other than coot)	Sept. 16–Nov. 30

Hunting licenses: Nonresident: General, $50; game birds only, $10; special bear permit (authorizes taking of 3 bears), $25. Resident: Big game, $5; game birds, $2. Guide license (citizen only), $5 (bond, $500). Permits to photograph birds and animals during January, February, March, and April, under supervision of commission, $5. Hunting predatory animals or bears in national forests, fee $1 for each dog. Licenses and permits issued by State game and fish commissioner, his chief assistant, chief clerk, assistant, and deputy game and fish commissioners, superintendents of fish hatcheries, justices of the peace, and persons authorized by State game and fish commission.

Bag and possession limits: 1 deer, 1 elk, 1 mountain sheep, 1 bear a season; under special permits, 1 bull moose, 3 bears (nonresident), a season; possession limited to 15 game birds of which not more than 6 may be sage hens, sage chickens, or grouse Federal limits on killing migratory game birds: 12 ducks (but not more than 8 of any one, or in the aggregate, of the following species—canvasback, redhead, scaup, ringneck, teal, shoveler, and gadwall), 4 geese, including brant, 20 Wilson's snipe, or jacksnipe, 25 coots, a day. Not more than two days' limit of ducks and geese, including brant, may be possessed at any one time.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season. Person possessing game during close season in State must show lawful taking.

Interstate transportation: Export of all protected game prohibited, provided, game may be exported if properly tagged by a justice of peace, assistant or deputy commissioners, or superintendents of fish hatcheries; fee, 50 cents. Game tags issued under affidavit that game was lawfully killed, and, if for edible portion, that it is not for sale. Not more than two days' bag limit of migratory game birds may be exported by one person in one calender week.

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[34] *Wisconsin:* Ducks and coots, or mud hens, may not be hunted on Wednesdays.

[35] Mixed daily bag limit of upland birds not to exceed 4 in the aggregate, but not more than 2 cock pheasants; mixed possession limit, 8 birds, but not more than 4 cock pheasants.

[36] *Wyoming:* Game and Fish Commission is authorized to issue 150 special bull moose permits a year, when conditions warrant. Fee: Nonresident, $50; resident, $25; and 2,000 special antelope permits, fee: Nonresident, $20; resident, $5.

LAWS OF CANADA

ALBERTA

Open seasons:	*Dates inclusive*
Deer, moose, caribou (must have horns at least 4 inches long)	Nov. 1-Dec. 14.[37]
Mountain sheep (male), mountain goat (must have horns at least 4 inches long)	Sept. 1-Oct. 31.[37]
Bear (except cubs or bear with cubs)	Sept. 1-June 14.[37]
Sharp-tailed grouse, north of Canadian Pacific Railway and Red Deer River	Oct. 1-Oct. 31.
In rest of Province	Oct. 1-Oct. 15.
Grouse, blue grouse, spruce partridge, north of Canadian Pacific Railway and Red Deer River only	Oct. 1-Oct. 15.
European gray partridge (Hungarian partridge)	Sept. 15-Nov. 30.
Duck, goose, Wilson's snipe or jacksnipe, coot, rails:	
North of Clearwater and Athabaska Rivers	Sept. 1-Nov. 14.
South of these rivers	Sept. 15-Nov. 14.

Hunting licenses: Nonresident: General, $50; Elk license, $50; game bird, $25. Resident: Big game, $2; special big game, $5; special elk, $10; bird, $2.50. Guide, $2.50 (guide may not act for more than three persons on any trip). Special license: Nonresident, $50; resident, $5 (issued to holders of general licenses and authorizes taking of deer, moose, and caribou in Rocky Mountain Forest Reserve of Alberta, north of North Saskatchewan River, Sept. 1 to Oct. 31, inclusive). Taxidermist, $5. Issued by minister of agriculture.

Bag and possession limits: Deer, moose, caribou, elk, mountain sheep, mountain goat, bear, 1 of each species a season; sharp-tailed grouse, 5 a day, 50 a season north of Canadian Pacific Railway; 5 a day, 25 a season south of said railway; Hungarian partridges, 15 a day, 200 a season; grouse, blue grouse, spruce partridge, 5 in aggregate a day, 25 a season; 15 ducks a day during September, 25 a day rest of season, 100 a season; 10 geese a day, 25 a season; 25 coots, 25 rails, 25 Wilson's snipe a day. Migratory game birds legally taken during the open season may be possessed until March 31.

Export: Export of all protected game prohibited, except that minister of agriculture may grant permits for export of game at rate of $5 for each head of big game and $1 a dozen for game birds. The holder of a general nonresident license may export as trophies, heads, skins, and hoofs of big game legally killed by him. Any person may export mounted or branded heads at a fee of $1 a head. Export of migratory birds prohibited during close season.

Miscellaneous: Use of live decoys in hunting migratory waterfowl prohibited.

BRITISH COLUMBIA

Open seasons: [38]	*Dates inclusive*
Bull moose, in Atlin, Fort George, Cariboo, and Omineca electoral districts; that part of Skeena district lying in eastern district; and Kamloops electoral district north of fifty-first parallel	Sept. 1-Dec. 15.
In Fernie and Columbia electoral districts (except south of Bugaboo Creek and west of Columbia River in Columbia electoral district)	Sept. 15-Oct. 31.
Bull caribou, in eastern district [39] except in Mackenzie and Skeena electoral districts, Cariboo electoral district west of Fraser River, and except south of main line Canadian Pacific Railway	Sept. 1-Dec. 15.
South of Canadian Pacific Railway	Sept. 15-Sept. 30.
Bull elk (wapiti) in Fernie and Columbia electoral districts (except west of Columbia River in Columbia electoral district)	Sept. 15-Oct. 15.
Male mountain sheep, in eastern district north of Canadian National Railway and in Cariboo and Lillooet electoral districts south of the main Chilcotin River, and west of Fraser River, and in Fernie, Cranbrook, and Columbia electoral districts	Sept. 1-Nov. 15.
Mountain goat in eastern district (except North and South Okanagan, and Grand Forks-Greenwood electoral districts)	Sept. 1-Dec. 15.
In western district [39] (except Vancouver Island)	Sept. 16-Dec. 15.
In rest of Province	No open season.
Male deer (mule, white-tail, coast) in eastern district [39] (see exception)	Sept. 15-Dec. 15.
Exception: White-tailed deer in North and South Okanagan and Similkameen electoral districts and west of summit of Midway Mountains in Grand Forks-Greenwood electoral district	No open season.
In rest of eastern district south of Canadian Pacific Railway(does only)	Dec. 1-Dec. 15.
In western district [39] (except Mayne Island)	Sept. 16-Dec. 15.
Bear (except white or Kermodei bear) in eastern district [39]	Sept. 1-June 30.
In western district [39]	Sept. 16-June 30.
Band-tailed pigeon, in western district only	Sept. 9-Oct. 15.
Duck (except eider duck), goose, brant, coot, Wilson's snipe or jacksnipe, in eastern district [39] (see exceptions)	Sept. 15-Dec. 31.
Exceptions: In Creston, Nelson, and Kaslo-Slocan electoral districts	Sept. 15-Nov. 30.
In Omineca, Fort George, and Atlin electoral districts	Sept. 1-Dec. 15.

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[37] *Alberta:* Deer, moose, and caribou, open season under special license in Rocky Mountain Forest Reserves of Alberta, Sept. 1 to Oct. 31, inclusive (see *Hunting licenses.*) Hunting of big game prohibited south of Saskatchewan River and east of Canadian Pacific Railway from Edmonton, Calgary, and McLeod. Moose protected south of Canadian Pacific Railway from Calgary to Banff.

[38] *British Columbia:* Regulations prescribing seasons, bag limits, and restrictions on sale of upland game birds for season 1933-34 are adopted by lieutenant governor in council. Full information may be had from provincial game commissioner, Vancouver.

[39] *Western district* includes that portion of Province west of summit of Cascades and south of Atlin electoral district, and, in the case of migratory birds, excluding that portion of Lillooet electoral district east of the easterly railway yard limit of Alta Lake railway station on Pacific Great Eastern Railway, and that portion of Skeena electoral district east of easterly railway yard limit of Shames on Canadian National Railway, bounded on the north by Atlin electoral district and on the south by Maitland Island and that part of Atlin electoral district south of fifty-sixth parallel and west of summit of Cascade Mountains. *Eastern district* includes rest of Province.

Open seasons—Continued.	*Dates inclusive*
Duck (except eider duck), goose, coot, Wilson's snipe, in western district [39]	Oct. 15–Jan. 31.
Black brant, in western district, including Atlin electoral district south of fifty-sixth parallel [39]	Nov. 15–Feb. 28.

Hunting licenses: Nonresident: General, $25, and $25 additional for each grizzly bear, moose, mountain sheep, wapiti, or caribou, $15 additional for each black or brown bear, mountain goat, or mule deer, and $5 additional for every deer of any other species shot by him; British subject, birds $5 a week. Resident British subjects or farmers as defined under game act, and members of army, navy, air forces, or militia on duty in Province: Deer and birds, $2.50; big game and birds, $5. Big game, birds, and trapping, $10; resident alien, $10 (big game and game birds only); guide, $5; taxidermist, $5. Issued by warden or any person authorized by him.

Bag and possession limits: [39] 1 moose, 2 caribou (except in eastern district south Canadian National Railway, limit 1), 1 elk (wapiti), 2 mountain sheep (except in Fernie, Cranbrook, Columbia electoral districts, and in Cariboo and Lillooet electoral districts, south of main Chilcotin River and west of Fraser River, limit 1), 2 mountain goats, 3 deer, 2 grizzly bears, 3 bears of any other species a season; 10 band-tailed pigeons a day, 50 a season; 20 ducks a day, 150 a season; 10 geese a day, 50 a season; 10 brant a day, 50 a season; 25 Wilson's snipe a day, 150 a season; 25 coots a day, 150 a season. (Limits on other species of game fixed by regulations of lieutenant governor in council.) Game may be possessed for 2 weeks after close of open season.

Export: Export of all game prohibited except under permit of provincial game warden.

MANITOBA

Open seasons:	*Dates inclusive*
Deer, moose, caribou, or reindeer (males)	Nov. 15–Dec. 5.
Prairie chicken, grouse, Hungarian partridge, ptarmigan (2 days)	Oct. 6, 11
Duck (except wood duck), goose, coot, rails, north of 53d parallel	Sept. 1–Nov. 30.
South of fifty-third parallel	Sept. 20–Nov. 15.
Wilson's snipe or jacksnipe	Sept. 15–Nov. 30.

Hunting licenses: Nonresident alien, big game, $40; birds, $25. Nonresident British, big game, $25; birds, $10. Resident, big game, $5; birds, $2. Issued by director of game and fisheries, department of mines and natural resources. License to hunt deer not issued after November 30.

Bag and possession limits: 1 in all of deer, moose, and caribou a season; 10 in all of prairie chicken, grouse, and Hungarian partridge; 15 ptarmigans a day, 50 a season; 15 ducks a day in September, 30 a day in October and November, 150 a season; 10 geese a day, 50 a season; 25 coots and rails, and 25 Wilson's snipe a day. Possession of ptarmigans allowed for 10 days after close of hunting season and of migratory game birds until March 31, but south of the fifty-third parallel the possession of more than 50 ducks or 15 geese is unlawful. Venison for private use may be possessed at any time on proof of legal killing. Heads and hides of big game legally taken within or without Province, may be possessed at any time.

Export: Export prohibited of all protected game, except under permit issued by department of mines and natural resources. No permit may be issued for export of ptarmigans, geese, ducks, or entire carcass of any moose, caribou, or deer; provided, nonresident licensee under permit issued free may export carcass of moose, caribou, or deer, and not more than 10 geese and 50 ducks killed by him. Export of migratory birds prohibited during close season.

NEW BRUNSWICK

Open seasons:	*Dates inclusive*
Deer (see exception)	Oct. 1–Nov. 30.
Exception: On Grand Manan Group, Campobello, and Deer Islands	Oct. 15–Nov. 15.
Bull moose (antlers must have 6 points)	Oct. 20–Nov. 20
Partridge (see exception)	Oct. 16–Oct. 31.
Exception: On Grand Manan, Campobello, and Deer Islands	No open season.
Duck (except wood duck), goose, brant, rail, coot, (see exception)	Sept. 15–Dec. 31
Exception: Islands in Grand Manan group	Oct. 15–Jan, 31.
Woodcock, jacksnipe, or Wilson's snipe (see exception)	Oct. 1–Nov. 30.
Exception: Islands in Grand Manan group	Oct. 15–Nov. 30

Hunting licenses: Nonresident: Big game, $5 (1 bull moose, 2 deer, 4 bears); $25 (2 deer, 2 bears) special license, $25 (4 bears, April 1–June 30); bird $25. Resident [40]: Big game, $3 (1 bull moose, deer); $2 (2 deer); bird, $1; taxidermist, $1; guide $1; camp help, $1.

Bag and possession limits: 2 deer, 1 moose (lumber camp limited to 2 moose and 4 deer) a season; partridges a day, 20 a season; 15 ducks a day, 150 season; 15 geese, 15 brant, 25 in all of rails, coots gallinules, and 25 Wilson's snipe a day; 8 woodcoc a day, 125 a season. Game may be kept for persona use in cold storage during close season under permi but migratory game birds may not be possessed afte January 31, except in Grand Manan group the may be possessed until the last day of February.

Export: Export of all game prohibited, excep game killed by nonresident licensee may b exported within 15 days after being killed, unde permit from Canadian customs office.

NORTHWEST TERRITORIES [41]

Open seasons:	*Dates inclusive*
Deer, moose, and mountain goat	Sept. 1–Mar. 31
Mountain sheep, caribou	Sept. 1–Feb. 28
Partridge, prairie chicken, ptarmigan, and other grouse	Sept. 1–Dec. 31
Duck, geese, brant, rail, coot, gallinule, Wilson's snipe	Sept. 1–Dec. 14

Hunting and trapping licenses: Nonresident $150. Nonresident British subject: General, $75 game birds, $5. Resident, $2. Trading or trafficking in game: Nonresident, $300; nonresident Britis subject, $150; resident. $5. Issued by Commissione of Northwest Territories. Permit from Commissioner required to establish trading post.

Bag and possession limits: 25 ducks, 15 geese 15 brant, 25 in all of rails, coots, and gallinules, an 25 Wilson's snipe a day. Migratory game bird legally taken during open season may be possesse until April 14.

Export: Export of the meat or the raw skins o game animals prohibited. except under permit fron minister or authorized officer.

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[39] See page 35.

[40] *New Brunswick:* Resident of Grand Manan Campobello, and Deer Islands may procure licens to shoot 1 deer, Oct. 15 to Nov. 15, and game bird other than partridge, fee $1.10.

[41] *Northwest Territories* means the northwest territories formerly known as Rupert's Land and th northwestern territory (except such portions thereo as are included in Provinces of Ontario, Quebec Manitoba, Saskatchewan, and Alberta and Yuko Territory), together with all British territories an possessions in North America and all islands adjacent thereto not included within any Province except Colony of Newfoundland and its dependencies."

NOVA SCOTIA

Open seasons:	*Dates inclusive*
Bull moose (except on Cape Breton Island, no open season), buck deer	Oct. 10–Oct. 31.
Hare, rabbit (see exception)	Nov. 15–Feb. 28.
Exception: On Cape Breton Island	Nov. 1–Feb. 28.
Ruffed grouse	Oct. 15–Oct. 31.
Woodcock and Wilson's snipe or jacksnipe	Oct. 1–Nov. 30.
Duck (except wood duck), goose, brant, rail, coot (see exceptions)	Oct. 1–Jan. 15.
Exceptions: Goose, brant, in Shelburne and Queens Counties	Nov. 1–Jan. 31.
Duck, rail, in Colchester and Cumberland Counties	Sept. 15–Dec. 31.

Hunting licenses: Nonresident or alien: General, $50; special deer license, $25; birds and small game except woodcock and snipe, $15; woodcock and snipe, $25. Resident: Big game, $2; guide, $2. Taxidermist, $5. Issued by minister of lands and forests, and agents.

Bag and possession limits: 1 buck deer, 1 moose a season; 5 ruffed grouse a day; 10 ducks, 5 geese, 5 brant, 25 in all of rails and coots, 25 Wilson's snipe, a day; 8 woodcock a day, 125 a season. Green hide or fresh meat of moose and deer may be possessed October 16 to November 20. Migratory game birds legally taken may be possessed for 1 month after close of open season, except that geese may be possessed until last day of February in Shelburne and Queens Counties.

Export: Export of all protected game, except hare and rabbit, prohibited, but holder of nonresident general license or special deer license, may ship out of Province under license tag 1 moose or 1 deer lawfully shot by himself.

ONTARIO

Open seasons:	*Dates inclusive*
Deer, bull moose, north of main line Canadian National Ry., between Quebec and Manitoba boundary lines	Sept. 15–Nov. 25.
South of Canadian National Ry. to Mattawa River and Canadian Pacific Ry. to Heron Bay, north shore Lake Superior	Oct. 20–Nov. 25.
South Canadian Pacific Ry. to Heron Bay and north Lake Nipissing and French River (see exception)	Nov. 1–Nov. 25.
Exception: On St. Joseph Island, Algoma district	Nov. 10–Nov. 25.
South of French and Mattawa Rivers	Nov. 5–Nov. 20.
Hare	No close season.
Woodcock	Sept. 15–Nov. 30.
Duck (except wood duck), goose, brant, Wilson's snipe or jacksnipe, rail, coot, gallinule, north and west of French and Mattawa Rivers and in all Georgian Bay waters (see exception)	Sept. 1–Dec. 15.
Exception: Eider duck north of Canadian National Ry. from Quebec boundary to Manitoba line only	Sept. 1–Dec. 15.
Duck (except wood duck and eider duck) south of French and Mattawa Rivers, excluding Georgian waters	Sept. 15–Dec. 15.

Hunting licenses: Nonresident: Game, $41; Game birds and rabbits, $21. Resident, moose, $6; deer, $4; camp license, $4 (allows 1 deer to 6 residents for food in camp); game, $1. Guide, $2. Issued by department of game and fisheries.

Bag and possession limits: 1 deer, 1 bull moose, a season; 15 ducks a day, 150 a season; 15 geese, 15 brant, 25 in all of rails, coots, and gallinules, and 25 Wilson's snipe a day. Eight woodcock a day, 125 a season. Two or more persons hunting together under license may kill an average of 1 deer each. Possession of all game legally taken permitted during open season and until March 31.

Export: Export of all wild game animals and birds prohibited, provided, 1 deer, 100 ducks, 1 bull moose, and under export permit bears or bear pelts, may be exported under nonresident hunting license if shipping coupon and, if required, affidavit of lawful killing be attached and contents of packages be open to view. Minister may issue permit for export of game, dead or alive, at any time, except migratory birds during close season.

PRINCE EDWARD ISLAND

Open seasons:	*Dates inclusive*
Hare, rabbit	Nov. 1–Feb. 1.
Partridge (open in odd, closed in even years)	Oct. 15–Nov. 15.
Woodcock, jacksnipe or Wilson's snipe	Sept. 15–Nov. 30.
Duck, goose, brant, rail, coot, gallinule	Sept. 1–Dec. 14.

Hunting licenses: Nonresident, $20; nonresident owner of real estate valued at $325 and paying taxes thereon, $5; sons, brothers, and sisters of residents returning for visit, $2.50; guest permit $2.25 per week. Issued by game inspector or justice of peace.

Bag and possession limits: 3 partridges a day; 10 ducks, 5 geese, 5 brant, 25 in all of rails, coots, and gallinules, and 25 Wilson's snipe a day; 8 woodcock a day, 125 a season. Migratory game birds legally taken in open season may be possessed until January 31.

Export: Export prohibited of all game, provided, nonresident licensee may carry out of Province 12 birds killed by himself if tagged and carried open to view. Export of migratory birds prohibitied during close season.

QUEBEC

Open seasons:	*Dates inclusive*
Bull moose (see exception)	Sept. 10–Dec. 31.
Exception South of St. Lawrence River	Sept. 20–Dec. 31.
Deer	Sept. 1–Nov. 30.
Caribou, in Gaspe, Bonaventure, and Matane Counties only	Sept. 20–Dec. 31.
Hare	Oct. 15–Jan. 31.
Bear	Aug. 20–June 30.
Birch or spruce partridge, sharp-tailed grouse	Sept. 1–Dec. 15.
White partridge or ptarmigan	Nov. 1–Jan. 31.
Duck, goose, brant, rail, coot, gallinule, woodcock, Wilson's snipe or jacksnipe	Sept. 1–Dec. 15.

Hunting licenses: Nonresident: General, $25 (members of incorporated hunting clubs, $10). Resident, not British subject, $5, resident, deer, $1, moose, $1. Special caribou license: Residents, $1; nonresidents, $1, in addition to $25 license. Resident British subject not hunting for own use must obtain special license. Issued by minister of colonization.

Bag and possession limits: 2 deer, 1 moose, 1 caribou, a season; 25 ducks, 15 geese, 15 brant, 25 in all of rails, coots, and gallinules, and 25 Wilson's snipe a day; 8 woodcock a day, 125 a season. Migratory game birds legally taken during open season may be possessed until March 31, and others during first 15 days of close season.

Export: Export of moose, caribou, and deer, or parts thereof, prohibited, except nonresident licensee may take out game animals killed by himself, under customs declaration and approval of Canadian collector of customs; export of grouse or partridges and of migratory birds prohibited during close season. Big game lawfully taken and coming from without Province may be transported under export permit of Minister of Colonization.

SASKATCHEWAN

Open seasons:	*Dates inclusive*
Deer, moose (males only), caribou (see exception)	Nov. 15–Dec. 14.
Exception: South of Township 35	No open season.
Hungarian partridge,	Oct. 1–Oct. 31.
Sharp-tailed grouse, or prairie chicken; pinnated grouse, or prairie hen	Oct. 1–Oct. 15.
Duck (except wood duck), goose, coot, Wilson's snipe or jacksnipe south of Township 61	Sept. 15–Nov. 14.
North of Township 60	Sept. 1–Oct. 31.

Hunting licenses: Nonresident alien: Big game, $50; birds $25; nonresident domiciled in Canada: Big game, $25; birds, $10; issued by minister of railways, labor, and industries. Resident: Big game, $5; birds, $1.50; issued by minister or agent.

Bag and possession limits: 1 moose a season; 2 deer or 1 deer and 1 caribou, 1 caribou a season: 10 Hungarian partridges a day, 30 a season; 5 of each species of grouse a day, 10 each in possession; 15 ducks, 5 geese, a day; 25 coots a day, 150 a season; 15 Wilson's snipe a day, but not more than 2 days' limit of each in possession at one time. Game birds may be kept in licensed storage from September 16 to last day of February, and flesh of big game from December 1 to April 1, if tagged with number and kind of game, name of depositor, and number of his hunting license.

Export: Export of all protected game prohibited; provided, nonresident licensee on leaving Province may take with him during open season personally under his license coupons and permit, big game and 100 game birds legally killed. Export of migratory birds prohibited during close season. Minister may issue permits to export deer (fee, $2 a head) or other big game (fee, $5 a head), hides of big game (fee, $1 each), flesh of big game (fee, $1 each 20 pounds or less); birds (fee, $1 a dozen; limits, 5 dozen ducks, 1 dozen geese, a season). No permit may be issued for the entire carcass of a moose, caribou, or other deer, and no person may export in 1 season more than 60 ducks or 12 geese.

YUKON

Open seasons:[42]	*Dates inclusive*
Deer, moose, caribou, mountain sheep, mountain goat (males only)	Aug. 1–Mar. 1.
Partridge, prairie chicken, grouse, ptarmigan, pheasant	Sept. 1–Mar. 15.
Duck, goose, brant, rail, coot, gallinule, Wilson's snipe or jacksnipe	Sept. 1–Dec. 14.

Hunting licenses: Nonresident, not Brtiish subject, $100; nonresident British subject, $75 (permits the killing of 1 moose, 2 deer, 2 caribou, 1 mountain sheep, and 1 mountain goat); licensee in addition may kill 1 moose, 2 deer, 2 caribou, 1 mountain sheep, and 1 mountain goat, but must pay a fee of $25 for each additional animal so taken. Nonresident, general game, $5. Resident, $25 (special license authorizing the killing of male moose and male caribou over 1 year of age at any time for food supplies in the Territory); licensee must make annual returns. Resident, general game, $1. Resident: Chief guide, $20; assistant guide, $10. Issued by commissioner or game guardian.

Bag and possession limits: (For limits on big game to a nonresident, see "Hunting licenses.") Six caribou, 6 deer, 2 moose, 2 mountain sheep, 2 mountain goats, 6 bears a season; 25 ducks, 15 geese, 15 brant, 25 in all of rails, coots, and gallinules, and 25 Wilson's snipe a day. Migratory game birds legally taken during open season may be possessed until April 14.

Export: Export of migratory birds prohibited during close season. Upon affidavit of lawful killing, commissioner may issue permit to export game. Export of raw hide of moose or caribou prohibited except under permit. Trophies, including head, hide, and hoofs, of big game lawfully killed by nonresident may be exported under his license and certificate of game guardian.

LAWS OF NEWFOUNDLAND

Open seasons:	*Dates inclusive*
Hare, rabbit	Oct. 1–Dec. 20.
Ptarmigan, willow grouse or partridge, geese, plover, curlew, snipe, or "other wild or migratory birds (except crows and hawks, unprotected)"	Oct. 1–Dec. 20.

Export: Export or canning of ptarmigan and other game birds prohibited.

Miscellaneous: Use of repeating or automatic shotguns prohibited.

LAWS OF MEXICO

Open seasons:	*Dates inclusive*
Deer (male), North of 20th parallel	Oct. 16–Jan. 31.
South of 20th parallel	July 16–Oct. 15.
On Cedros Island	No open season.
Antelope, mountain sheep	No open season.
Bear	Sept. 1–Oct. 31.
Rabbit	Sept. 1–Feb. 28.
Peccary	Aug. 1–Feb. 28.
Grouse	Sept. 1–Sept. 30.
Quail, partridge	Jan. 1–Apr. 30.

Open seasons—Continued.	*Dates inclusive*
White-winged doves	Sept. 16–Nov. 30.
Other doves and pigeons	Oct. 1–Dec. 31.
Wild turkey (see exception), cojolite	Sept. 1–Dec. 31.
Exception: Wild turkey in Coahuila, Nuevo Leon, and Tamaulipas	Feb. 15–Apr. 30.
Armadillo	Nov. 1–Jan. 31.
Tapir	Sept. 1–Nov. 30.
Ducks, geese, shorebirds	Nov. 1–Feb. 28.

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[42] *Yukon:* Indians, explorers, surveyors, prospectors, miners, and travelers in need of food may take game during close season. Commissioner in council may alter seasons.

FIELD SERVICE, DIVISION OF GAME AND BIRD CONSERVATION BUREAU OF BIOLOGICAL SURVEY

[Violations of Federal game laws may be reported to the nearest official listed, or to the Chief, Bureau of Biological Survey, United States Department of Agriculture, Washington, D.C.]

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1718

IMPORTANT SUGAR-BEET BYPRODUCTS *and Their* UTILIZATION

THE beet-sugar industry has several byproducts that are of importance to agriculture. In harvesting sugar beets the tops, which constitute about one half of the weight of the marketable roots, are cut off in the field. In the processing of the sugar beet into sugar, pulp and molasses are produced as byproducts. These byproducts are important feeds for fattening cattle and sheep in the areas where they are produced. They are also used advantageously in a variety of rations for dairy cattle and to some extent in feeding other livestock, such as horses, swine, goats, poultry, and rabbits. In general, the dry matter of these byproducts has practically the same feeding value as that of grain when they are fed in properly balanced rations. Lime cake, another byproduct of beet-sugar manufacture, serves the same purpose as ground limestone in growing legumes that do not thrive in an acid soil, and in improving the texture of the soil.

The different forms in which these byproducts are available and their value for livestock feeding and soil improvement are discussed in this bulletin. Specimen rations for feeding different classes of livestock are given on pages 27 to 29, inclusive.

Supplementary information relating to the production and feeding of sugar-beet byproducts may be obtained on request from the United States Department of Agriculture, Washington, D.C., and from the agricultural experiment stations located in the various sugar-beet producing States.

This bulletin supersedes Farmers' Bulletin 1095, Beet-Top Silage and Other Byproducts of the Sugar Beet.

Washington, D.C. **Issued January 1934**

IMPORTANT SUGAR-BEET BYPRODUCTS AND THEIR UTILIZATION

By A. W. Skuderna, *principal agronomist, Division of Sugar Plant Investigations, Bureau of Plant Industry,* and E. W. Sheets, *principal animal husbandman, Animal Husbandry Division, Bureau of Animal Industry*[1]

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IMPORTANCE OF SUGAR-BEET BYPRODUCTS IN LIVESTOCK FEEDING

THE BEET-SUGAR INDUSTRY produces directly from the sugar beet several byproducts—beet tops, pulp, and molasses—which constitute an important source of livestock feed. Abroad, through more than a century of sugar-beet growing, the value of these byproducts has become increasingly appreciated, and they have been efficiently utilized. In the United States the value of these byproducts has not as yet been fully realized, and in some localities full advantage has not been taken of these available feeds. A more general recognition of the true worth of the byproducts of the sugar beet is necessary for their effective utilization. With the 1931 production of beet pulp valued at approximately $3,000,000, the yield of beet tops if utilized for feeding worth practically as much more on the basis of acreage planted, tonnage of beets produced, and feeding value, and with beet molasses estimated at about $400,000, the aggregate amounts to more than $6,000,000 annually. This sum, as compared with $81,812,489, which was the total value of the beet sugar produced in this country in 1931, as reported by the Bureau of the Census, affords a basis for judging the importance of these byproducts.

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[1] Acknowledgment is made of indebtedness for assistance in assembling information on sugar-beet byproduct utilization to H. E. Brewbaker, C. E. Cormany, S. B. Nuckols, and to other members of the agronomy unit of the Division of Sugar Plant Investigations; to S. H. Hastings, Beyer Aune, Daniel Hansen, J. O. Holden, and other members of the Division of Western Irrigation Agriculture; to D. A. Spencer and A. T. Semple of the Animal Husbandry Division, Bureau of Animal Industry; to J. B. Shepherd and G. Q. Bateman, of the Division of Dairy Cattle Breeding, Feeding, and Management, Bureau of Dairy Industry; to E. J. Maynard, Utah Agricultural Experiment Station; and to G. E. Morton, B. W. Fairbanks, and others of the Colorado Agricultual Experiment Station. The American Beet Sugar Co., The Amalgamated Sugar Co., The Great Western Sugar Co., The Holly Sugar Corporation, The Utah-Idaho Sugar Co., and other beet-sugar companies furnished information pertaining to their districts. The assistance received from these sources is gratefully acknowledged.

In addition to this domestic production, 41,224 tons of dried beet pulp, with a declared value of $638,215, were imported in 1931 for consumption.

As a further indication of the value of sugar-beet byproducts, attention is called to the fact that 3 of the 4 principal lamb-feeding sections in Colorado correspond to the principal beet-producing sections. In these 3 sections are fed approximately 30 percent of all lambs fattened in the United States during the winter feeding season.

Carefully conducted tests have been made by several of the State and Federal experiment stations in determining the value of sugar-beet byproducts when fed to various classes of livestock. It is the purpose of this bulletin to bring to the attention of the reader some of these results, together with the generally favorable experiences of the already large body of feeders of livestock successfully using these byproducts, so as to encourage a general appreciation and careful and efficient utilization of the beet tops, pulp, and molasses in rations for the economical feeding of livestock.

TOPS

Sugar beets are purchased from the grower by the beet-sugar company primarily for their sucrose content. In the crown of the beet certain salts accumulate that tend to interfere with the recovery of sugar from the juices and, therefore, the grower is required to remove that portion of the beet to which the leaves are attached. This discarded portion, which is left lying on the ground in the field when the beets are harvested, is known as the beet top or tops. It consists of about one third crown and two thirds leaves. Its initial moisture content ranges from 75 to 90 percent. Assuming the average initial moisture content of the tops to be about 85 percent, there would be about 300 pounds of dry matter in a ton of such tops.

The proportion of the green weight of the top to the root varies with the locality and with the season. In the irrigated area usually these tops will range in weight from 30 to 70 percent of the marketed weight of beets produced, depending on fertility of the soil and relative freedom from defoliation caused by hail, insect pests, and fungous diseases. In the humid area the tops may constitute a higher proportion of the beets produced. Because of this wide range, and also because of the tendency of the tops to increase or decrease in weight, depending on climatic conditions and the period of harvest, the general practice of purchasing them on a basis of tops to tons of beets produced has been resorted to in those areas where a ready market exists for this commodity. Assuming that the weight of the tops amounted to 60 percent of the marketed weight of the beets produced, this would mean that a 15-ton beet crop would produce 9 tons of green or fresh tops.

HANDLING

An increasingly popular field practice is to throw the beets into windrows before topping them (from 12 to 16 rows of beets are windrowed together), and then to cut the tops off with a sharp knife. In some cases, after the beets have been delivered these tops are placed in small cocks not larger than an inverted washtub and allowed to cure. When cured, they are hauled to the feed lot and are either stacked or fed as hauled (fig. 1). In other cases they are pastured by cattle or sheep in the field (fig. 2). Under present conditions, the hauling of tops fresh from the field is not extensively practiced. In fact, in several of the western beet-growing areas the ensiling of tops has been practically discontinued. There are still, however, some beet growers and feeders who prefer feeding beet tops as silage to feeding them in any other way.

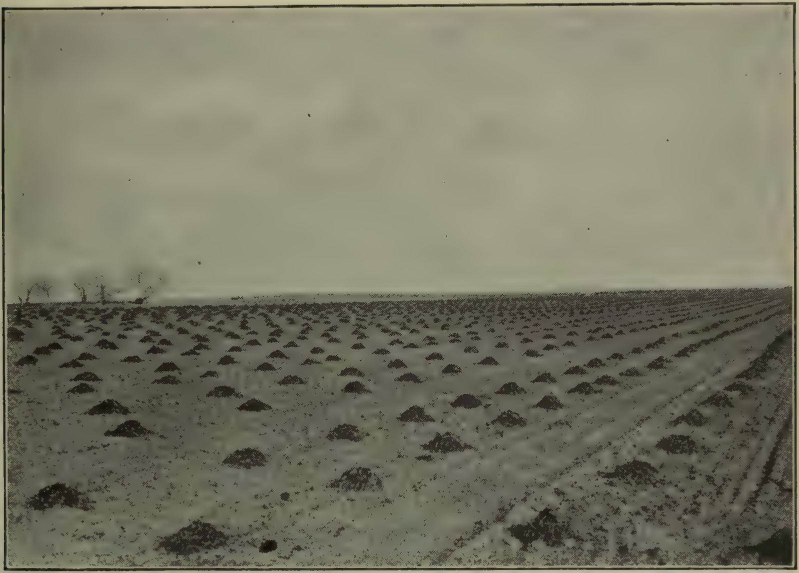

FIGURE 1.—Beet tops piled in the field, affording a readily accessible supply of feed.

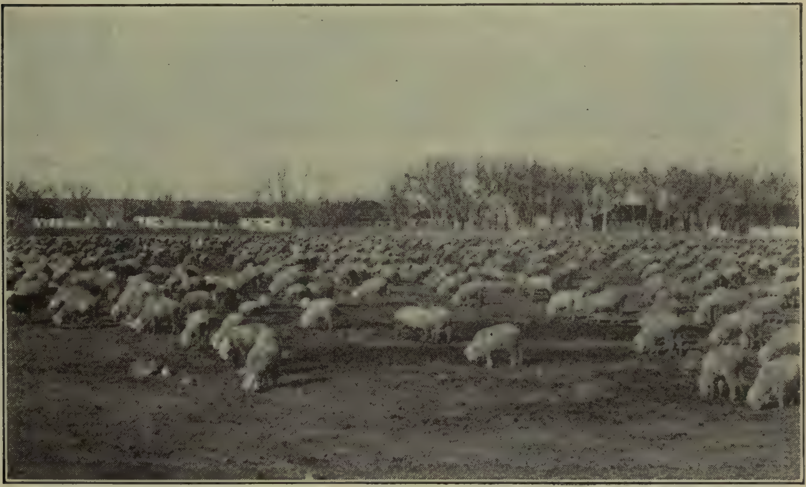

FIGURE 2.—Pasturing sheep on beet tops left scattered in the field.

Considerable progress has been made in some of the beet-growing sections of the United States in caring for and feeding tops. In one area where topping the beets from windrows is the prevailing practice, more than 80 percent of the tops are piled when partially dry and hauled as needed to the feed lot. Tops that have been piled properly in the field directly from the windrows are generally a much better feed and are more fully utilizable than tops that have been lying scattered in the field, subject to loss by being covered with snow (fig. 3), trampled in the mud by the stock, or injured by alternate leaching and drying, and to the additional loss resulting from the shattering of the leaves. When the tops are pastured during a rainy season there is not only a considerable waste of feed, but there is also the detrimental effect of packing the soil when wet, which often results in a cloddy condition that is difficult to overcome in the spring (fig. 4). In some fields, the tendency for the soil to wind-drift is increased by pasturing in the field. Where weather and soil conditions are favorable, however, and if the field is not going to be fall-plowed, pasturing the tops may sometimes be justified. This is especially so in cases where beets have been grown on nematode-infested land. From such fields the tops should never be hauled.

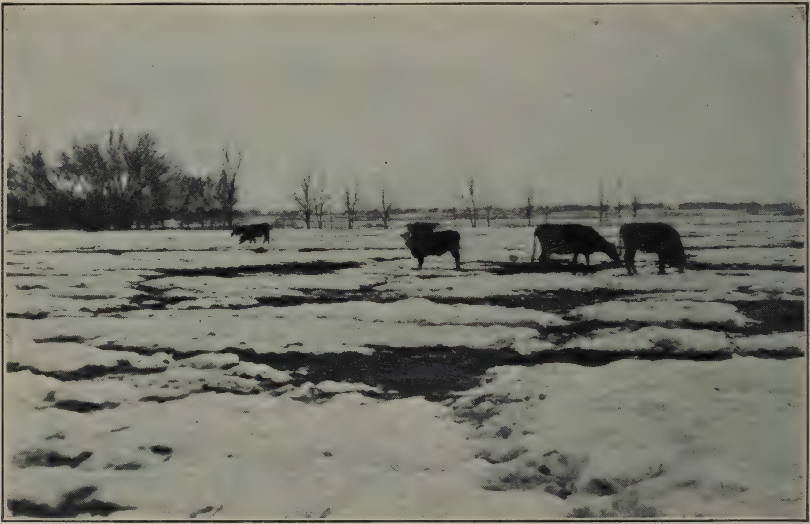

FIGURE 3.—Tops left scattered in the field and pastured under adverse weather conditions, resulting in loss in feed value.

Some beet growers prefer to stack the tops as soon as they are thoroughly dried, to avoid losses in feeding value which would occur if they were left in the field in piles. In some cases the tops are stacked even though not fully dried, and a 2- or 3-inch layer of straw is alternated with a 6- or 8-inch layer of tops. An efficient size of rick for convenience in feeding is one which is about 8 or 10 feet wide, about 12 feet long, and 10 feet high. An ordinary hay knife is used to cut the stacked tops. Tops properly stacked, even though

3 years old, have been relished by livestock. Where livestock is not available, the immediate plowing under of the green tops is advisable, as the tops have considerable value as a green manure.

FEEDING

As beet tops are quite palatable when properly handled and contain strongly cathartic salts, they should be fed with care, and supplementary feeds that counteract the laxative effect used wherever practicable. Inasmuch as beet leaves contain considerable oxalic acid, they are dangerous when fed in large quantities to pigs and horses. The amount fed should not exceed 1 pound of fresh green tops per 100 pounds of live weight. Fermentation in the paunch of ruminants destroys part of this acid. However, too liberal feeding may result not only in scouring but also in indigestion. German investigators have observed that 1 ounce of precipitated chalk fed with 50 pounds of leaves will counteract much of the unfavorable effect of the acid.

FIGURE 4.—Texture of soil detrimentally affected by livestock being allowed access to the field in wet weather. In spite of considerable reworking, a poor seed bed was obtained the following spring.

In making silage from beet tops produced on sandy soil, care should be taken to shake out as much sand as possible in handling them, to avoid digestive trouble resulting from too much sand being incorporated in the silage.

Experiments conducted by the Colorado Agricultural Experiment Station show that an average acre of tops is equal in feed value to a ton of alfalfa hay, and that a ton of dried tops and a ton of alfalfa hay are equal to 2 tons of alfalfa hay fed alone, in putting gains on steers during the first 6 weeks of the fattening period.

Generally where the tops are pastured in the field, a fixed rate per day per animal is assessed, varying with the class of livestock pastured and the prevailing prices for other feed.

In regard to the general feed value of tops that have been carefully handled in an effort to conserve their nutritive value, the Colorado Experiment Station stated in 1928 that, according to feeding tests, beet tops are worth about twice as much when fed in properly balanced rations as is commonly charged for them.

Many of the beet-sugar companies have large-sized feeding pens (see illustration on title page) located immediately adjacent to the factory grounds. Some of the beet-sugar companies also furnish their beet growers with cattle to feed on a " pound gain " basis, at a certain specified price per pound. Such a practice encourages considerable feeding of small groups of cattle by farmers who have the feed and the equipment but who lack the capital required for the purchase of cattle.

BEET TOPS FOR BEEF CATTLE

In order to use the tops to best advantage by grazing, enough cattle per acre should be used to clean them up fairly well in about 6 weeks.[2] Accordingly, an acre of beets yielding about 8 tons of tops would produce sufficient feed to graze two or three 2-year-old steers for 40 days. In addition, about 10 pounds of hay per steer per day should be fed. Under favorable conditions steers should gain about 1 pound per head daily. A heavier rate of grazing is desirable when fencing can be so handled that the cattle are confined to an area of tops they will clean up in a week to 10 days. Experiments conducted by the Colorado Station show the influence weather has on the utilization by animals in the pasturing of tops. Two-year-old steers pastured under ideal weather conditions required tops from only 6 tons of beets and 317 pounds of alfalfa hay to produce 100 pounds of gain at the rate of 1.9 pounds per head daily. The next fall, with severe storms, it took the tops from 24 tons of beets and 2,137 pounds of alfalfa to produce like gains at the rate of 0.6 pound per head daily. In the latter case most of the tops were wasted because of being trampled in the mud. The increased consumption of hay was due partly to the much lower rate of gain.

In a series of 3 tests in Colorado, in 1 bad and 2 good years, it paid best to haul the tops and feed in dry lot, but with normally only 1 bad fall out of 5 or 6, it would be more economical to pasture them.

BEET TOPS FOR SHEEP

In some of the sugar-beet-growing areas where sheep feeding is extensively practiced the tops are generally pastured in connection with grain and alfalfa stubble on a basis of 1 cent per head per day. The Colorado Station states that ordinarily the tops from 14 tons of beets, if there is little or no waste, will furnish feed for 1,000 lambs for 1 day. Where the lambs also have access to stubble land, the tops from 7 tons of beets and 1½ acres of alfalfa stubble and small-grain stubble should carry 1,000 lambs for 1 day. Lambs pastured or fed on tops and roughage should gain from 0.15 to 0.2 pound per head daily. In good weather lambs pastured on tops have made heavier and cheaper gains than lambs fed tops in dry lot. If tops are fed in dry lot, it is not good practice to feed them through panels, because the lambs pull many of the tops through, trample, and waste them. It is best to scatter on clean straw just what tops the lambs will clean up each day. The tops from a ton of beets fed with grain and alfalfa will replace about 20 pounds of grain and 100 pounds of alfalfa, provided there are no tops wasted.

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[2] In pasturing beet tops or feeding them in dry lot, cattle should be watched rather closely to prevent their choking on the beet tops. This condition can be relieved by carefully inserting in the gullet a loop of smooth wire to remove the obstruction.

Averaging the results of three consecutive lamb-feeding experiments at the Scotts Bluff Field Station, Mitchell, Nebr., the addition of beet tops to a fattening ration of alfalfa and equal parts of barley and dried pulp reduced the requirements of corn and dried pulp 14 percent, increased the rate of gain 15 percent, the appraised value nearly 4 percent, and the profit per lamb 40 percent.

At the Huntley Field Station, Huntley, Mont., in four consecutive experiments (1929–32) in fattening lambs, the addition of 2¼ pounds of choice-quality well-dried tops to a ration of 1.1 pounds of barley and 2.4 pounds of alfalfa hay increased the rate of gain 16 percent and reduced the hay consumed per lamb per day fully one third. In other words, 3 pounds of tops replaced 1 pound of alfalfa hay, reducing the alfalfa from 2.4 to 1.6 pounds and increasing the gain from 0.29 to 0.34 pound per head per day. There was no change in the barley consumption, and the sale price was practically the same.

BEET TOPS FOR DAIRY CATTLE

Feeding beet tops to dairy cattle has been attended with varying degrees of success, depending on the conditions of the tops when fed and the degree to which the after effects were noticed in the milk produced.

Opinion is divided as to the effect of feeding beet tops in tainting milk. Some dairymen maintain that when beet tops are allowed to become much wilted or dried before being fed, and then are fed in normal amounts after milking, no tainting of milk will result. Other dairymen advocate the feeding of fresh tops not to exceed 20 pounds per cow after milking with some supplementary feed and a little grain mixture to overcome some of the purgative effect of the beet tops. Still others claim that regardless of precautions taken, that feeding of beet tops and wet or siloed beet pulp to dairy cows will tend to produce off-flavored milk. Everything considered, however, experience indicates that the feeding of fresh tops and wet or siloed pulp in moderate amounts with some supplementary feed after milking, will reduce to a minimum this objectionable tendency.

The value of pasturing beet tops as compared with feeding them in the dry lot is seen in the following experiences. In one instance 18 cows were pastured on tops, and the production of milk dropped shortly after the cows began pasturing and did not return to normal until after the tops had all been pastured. In the second case, the cows were dry-lot fed, at first on a small amount of green tops, and later one half the hay ration was replaced with tops. These cows gained in milk flow with the beginning of feeding beet tops and maintained a normal flow during the winter. Estimating the value of the tops at 25 cents per ton on the basis of beet tonnage produced, the pastured tops cost $2.10 per month per cow, and $1.30 per cow per month when fed in the dry lot. Besides this saving in feed cost, there was a substantial difference in average butterfat production in favor of dry-lot feeding. There was a production of 304 pounds of butterfat per cow fed tops in the dry lot, as compared with 278 pounds per cow pastured upon the tops.

In another instance, a dairyman fed in a ration beet tops from 66 acres that yielded 1,196 tons of beets. The sale value of tops in this case, also on the basis of 25 cents per ton of beets produced, was $299, or $4.53 per acre. In actual feed value, however, this quantity of tops replaced 99 tons of alfalfa hay valued at $7 per ton, giving a return of $10.50 per acre for beet tops.

Some dairymen state that when beet tops are pastured while in a fresh condition they have the same replacement value as fresh pulp, while others state that if the dairy animals were fed beet tops alone the tops would replace from one half to all of the alfalfa hay for a short time without bad results. Those dairymen who feed tops in the feed lot prefer this method of feeding because less scouring of the cattle occurs.

PRESERVING BY DRYING

Many inquiries have been made by sugar-beet growers and feeders of livestock relative to artificial drying of sugar-beet tops. As there are numerous cases of artificially drying alfalfa and other crops, and as such a process, properly controlled, produces feed as good as or better than hay naturally dried, there seems to be no reason why artificial drying should not be applied to beet tops, if it can be done economically.

Preservation of sugar-beet tops by drying is practiced in several of the beet-growing areas in Europe, and much progress has been made in developing machinery to handle this byproduct. After most of the adhering soil has been removed by washing, the tops are chopped up, to insure even drying, then pressed to about 25 percent dry matter, and dried (in kilns very similar to those used in the factory for drying the pulp) to a moisture content ranging from 10 to 15 percent. The dried product is highly esteemed in Europe, has a ready market, and in feeding value is generally considered equal to oats.

PRESERVING BY SILOING

While in certain areas beet tops are fed generally, either in a fresh state or fully cured, there are other areas where, because of weather considerations, it is not possible to feed them in either of these ways and where siloing is the most practical method of handling them. The Colorado Experiment Station has found with regard to beet-top silage that when beet tops are ensiled in an effort to conserve them and furnish a succulent feed during the whole feeding period, although the silage gives fairly good results for the short preliminary feed, it is impractical for the entire feeding period. It was further found that beet-top silage, like most protein silages, spoils quickly when exposed to the air and causes digestive disturbances and scouring, especially when the weather becomes warm. Piling tops in small piles in the field and pasturing or hauling and feeding them in dry lot was more satisfactory than when the tops were ensiled. On account of loss in moisture in the ensiling process, 100 pounds of beet-top silage contains about one third more dry matter and therefore more feeding value than found in a similar quantity of fresh tops.

On the other hand, according to one authority, it has been found in Germany that sugar-beet tops, once harvested, should be fed, as far as possible, in a fresh condition, and such excess as cannot be fed fresh should be siloed, on the theory that a correct process of siloing will not result in losses higher than those that are incurred by storage in the field.

Some sugar-beet growers, especially in the humid area where it is difficult to cure beet tops in the field, find it profitable to silo the green tops, either with or without straw. The soil should be removed from the tops before they are placed in the silo. This is an important precautionary measure, as compacting of silage in the stomach of the animal is almost sure to follow when there is much soil in the silage. As horses seem especially affected by such compacting, as a rule no beet-top silage is fed to them.

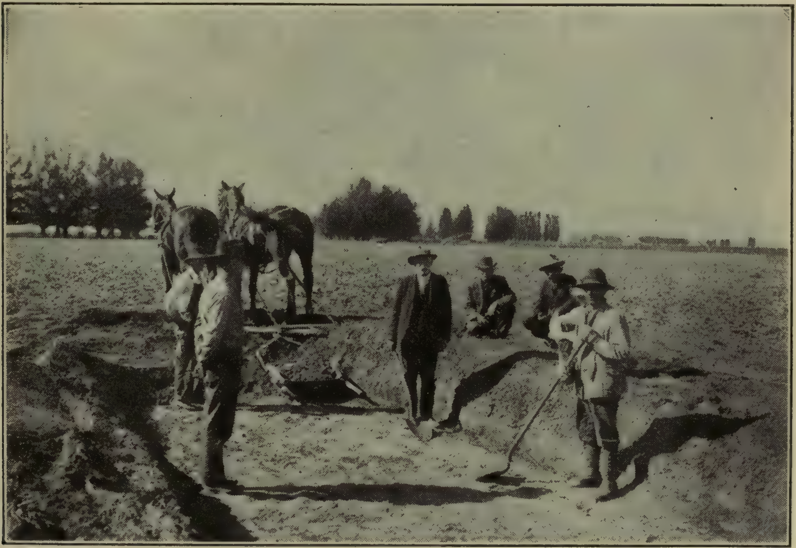

FIGURE 5.—Trench silo showing shallow excavation in which beet tops are piled to be conserved by the trench-silo method. The dimensions of the silo vary according to quantity of tops to be siloed.

When the tops are fresh and green they can be alternated in the silo with layers of straw. When the tops are dry they should be siloed without the addition of straw, as a much more thorough packing of the siloed mass is required where straw is used. Good results have also been reported in using silage made from alternate layers, about 6 inches thick, of beet tops and wet beet pulp.

While the ordinary stave or concrete silo can be used successfully for siloing beet tops, the more common practice is to silo them in an ordinary trench or pit silo located conveniently near the feed lot. The depth of such a silo will depend on adequate drainage. In soils provided with good underdrainage (fig. 5) the silo can be made deeper than in soils that have a high-water table, necessitating the construction of the silo aboveground. If the silo is constructed aboveground the wastage of feed is greater.

The tops (which as a rule are not run through a silage cutter before being placed in a trench or pit silo) are hauled to the silo, which is filled as quickly as possible (the mass being sprinkled with water if necessary), tightly and evenly packed by driving the teams and wagons over the layers, and the top and sides sealed either with a heavy layer of wet beet pulp if available, or with an 8- to 10-inch layer of fine, chaffy straw. In a period of 5 to 6 weeks the mass has fermented sufficiently to be used as needed. Some beet growers silo the beet tops in stave or concrete silos by running the particular roughage they have available and the beet tops through a silage cutter in the proportion of 75 percent by weight of tops to 25 percent by weight of the other roughage. Several of the growers use from 3 to 5 pounds of salt per ton of beet tops at the time of siloing to make the silage more palatable and to improve its quality. When the silage is ready to feed from a trench silo, a large hay knife or sharp spade can be used and the silage cut across one end from top to bottom and forked out as it is needed.

BEET-TOP SILAGE FOR BEEF CATTLE

While beet-top silage is usually less valuable pound for pound than corn silage, it is quite a satisfactory substitute in maintaining and fattening beef cattle. A definite comparison is difficult to make on account of the variable water content of both products. When cattle are fed a predominating sugar-beet byproducts ration consisting of about 25 pounds of beet silage, 60 pounds of siloed beet pulp, 10 pounds of alfalfa hay, 4 pounds of discard beet molasses, and about 3 pounds of cottonseed cake, as a daily feed per 1,000 pounds of live weight, they usually make an average daily gain ranging from 2 to 2½ pounds per head. For maintenance, about 25 pounds of beet-top silage and 10 pounds of alfalfa hay per 1,000 pounds live weight make a good ration. If alfalfa is not available, from 10 to 15 pounds of oat straw may be used.

BEET-TOP SILAGE FOR SHEEP

Beet-top silage is not generally fed to sheep, and such feeding tests as have been conducted with this feed have shown it to be unsatisfactory as a succulent feed for lambs. It causes digestive disturbances, and considerable scouring is likely to occur. In one experiment conducted at the Colorado Agricultural Experiment Station 1 pound of beet-top silage was not as good as 1 pound of corn or sunflower silage or 3 pounds of wet pulp when fed with a pound of grain and 1⅔ to 2 pounds of alfalfa hay.

BEET-TOP SILAGE FOR DAIRY CATTLE

It is believed by some dairymen that beet tops cannot be fed to dairy animals in any manner except as beet-top silage if the production of off-flavored milk is to be avoided. Where used, it is generally fed following milking, a daily ration of about 25 pounds of silage, 10 pounds of legume hay, and about 7 pounds of grain and dried-pulp mixture being used per 1,000-pound animal giving about 25 pounds of milk daily.

PULP

In the process of beet-sugar manufacture the beet is sliced in the factory into long, thin, angular slices called "cossettes" and extracted with warm water, to dissolve out the sugar known as "sucrose." The fibrous mass which remains after extraction is called "pulp" and contains from 5 to 9 percent of dry matter, the remainder being water. The amount of pulp produced per ton of beets sliced usually varies in direct proportion with the richness of the beet, being generally higher in higher testing beets, and lower in lower testing beets, the yield of marketable wet and siloed pulp ranging from 20 to 30 percent of the weight of beets purchased.

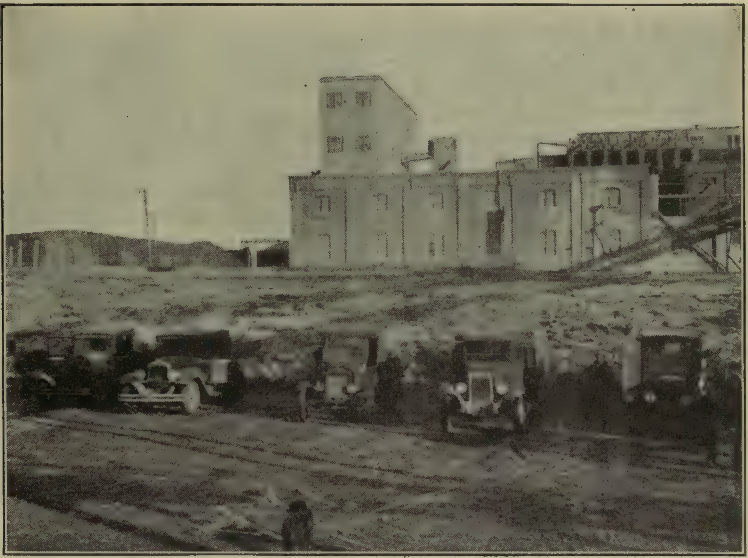

FIGURE 6.—Beet-sugar factory with basin silo and trucks for hauling siloed pulp.

In some factories the wet pulp is pressed through rollers to squeeze out a certain amount of excess water to reduce the cost of transportation. The resulting product is known as pressed beet pulp and contains about 15 percent of dry matter. Beet-sugar factories not equipped with pulp-drying equipment, or those not desiring to dry their entire output of pulp, store the excess pulp in huge pits commonly called pulp silos, where the fresh unpressed pulp undergoes fermentation and results in a product known as "siloed pulp." This fermented pulp appears to be as palatable as the fresh pulp and is more satisfactory to feed, as it does not freeze quite so quickly when it is being handled in cold weather.

The dry-matter content of the pulp increases gradually during the storage period from about 8 percent in September to 10 percent in November, to 12 percent in January, and 14 percent in April. In selling pulp to farmers the price charged is gradually increased to correspond to the concentration which occurs.

Wet pulp and siloed pulp are distributed to feeders within a short hauling distance by truck or wagon from the factory. The siloed pulp is in great demand because of its feeding value and is hauled throughout the feeding period to feed lots within reasonable hauling distance of the factory (fig. 6). Pressed pulp is mostly shipped out by rail to feeders within a radius of approximately 10 to 50 miles.

At the Colorado Agricultural Experiment Station it was found that, although the wet-pulp recovery from factory silos amounted to about 25 percent of the weight of beets purchased, the wet-pulp allotment or the amount the beet grower was allowed to purchase usually ran from 15 to 45 percent of the beet tonnage delivered, depending on the proximity of the beet-producing area handled by the factory and on the local demand for pulp. Under this allotment the average feeder received 75 to 225 tons of pulp, which was often insufficient for a complete fattening operation without the addition of a supplementary feed of like nature.

In Colorado in recent years some factories have installed equipment for pressing the free moisture from the pulp in cold presses as it leaves the factory. Although this pressed pulp contains only 5 percent less moisture, it contains one third more dry matter than ordinary wet pulp. In other words, two thirds of a ton of pressed pulp (85 percent moisture) contains as much dry matter as a ton of wet pulp (90 percent moisture). The production of pressed pulp enables the different factories to maintain a more uniform allotment figure, as the pressed pulp is better adapted to shipment and widens the pulp-feeding territory. Where siloed pulp was once used within a radius of 3 or 4 miles of the factory, it is now trucked as far as 16 miles and is shipped by rail even farther.

FEEDING WET PULP

Studies were made at the Colorado Station to determine the relative value of wet pulp siloed at the factory and pressed pulp siloed on the farm. A summary of two tests shows that wet pulp hauled from the factory silo and paid for on a factory standard-shrinkage basis gave a profit of $1.85 per ton fed, while pressed pulp stored on the farm gave a profit of $1.33. In fattening calves for 194 days equal quantities of pressed beet pulp and siloed beet pulp had the same feeding value. The average ration was 26 pounds of pulp, 4 pounds of ground barley, 1.1 pounds of cottonseed cake, and 6 pounds of alfalfa hay.

The principal advantage in the pressed pulp appears to be its greater adaptability for shipping and storage which thus widens the pulp-feeding area. Studies at the station have indicated that an ordinary trench silo is most efficient in storing pressed pulp on the farm. A trench silo 5 feet deep, 12 feet wide, and 100 feet long holds 150 tons of pressed pulp.

A straw silo of the same capacity, constructed with 12-foot posts, 5-foot woven wire stretched on either side of the posts, and straw packed in between, costs nearly four times as much as the trench silo.

There was a 27 percent loss of weight on pulp stored in the trench silo, a 28 percent loss on pulp stored in the straw silo, and a 34 percent loss on pulp stored in an open pile on the ground. Many feeders pile a portion of the pulp they haul from the factory silo, and trench silos would pay where any considerable amount is stored.

The analysis of sugar-beet pulp as given in table 1 does not show all of its value as a feed in a properly balanced ration, because it is very palatable, stimulates the digestive processes, and gives livestock a more thrifty appearance. Generally, pulp-fed cattle gain as well as or better than cattle fed on corn silage, are sleeker, and sell fully as well. In addition, the crude fiber of root crops is more digestible than that of other forage plants at the time they are usually harvested for feed.

TABLE 1.—*Comparison of digestible nutrients in the concentrates, barley and dried beet pulp, and in the roughages, alfalfa and timothy hay*[1]

Kind of feed	Water	Ash	Crude protein	Carbohydrates		Fat or ether extract	Digestible protein	Digestible carbohydrate equivalent
				Crude fiber	Nitrogen-free extract			
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Barley	9.6	2.9	12.8	5.5	66.9	2.3	10.4	63.8
Fresh beet pulp	90.5	.4	.9	2.2	5.8	.2	.5	7.1
Dried beet pulp	8.4	3.5	9.3	18.7	59.3	.8	4.9	66.0
Alfalfa hay	8.3	8.9	16.0	27.1	37.1	2.6	11.5	42.0
Timothy hay	12.5	5.4	6.8	28.3	44.3	2.7	3.3	44.7

[1] Compiled by the Cereal Section, Food and Drug Administration, and the Animal Husbandry Division, Bureau of Animal Industry, U.S. Department of Agriculture. The carbohydrate equivalent is the sum of the digestible crude fiber and nitrogen-free extract plus 2.25 times the digestible fat.

The results of a great many experiments and the experiences of livestock feeders, in general, prove that a pound of dry matter in beet pulp is equal to a pound of dry matter in grain, and that a pound of dried beet pulp or dried-molasses beet pulp is equal to a pound of grain in a properly balanced ration. Being largely a carbohydrate feed like the grains, and quite deficient in protein, lime, and phosphate, it should be fed with legume hay, such as alfalfa, and oil-mill byproducts, such as cottonseed or linseed meal.

Until recent years, rations of wet beet pulp with hay or straw were used to fatten mature cattle and sheep. Such rations are too bulky for good results with younger stock. By adding concentrates, such as grain and cottonseed cake, beet byproduct rations have been developed that are as effective in the fattening of calves, yearlings, and lambs as in the fattening of older stock.

WET BEET PULP FOR BEEF CATTLE

Nearly 20 years of experimental feeding work at the Colorado Station shows that there is no fattening ration for cattle that will produce as cheap or satisfactory gains as a ration containing a liberal amount of wet beet pulp. Calves fattened on a ration of ground barley, cottonseed cake, and alfalfa hay gained 1.83 pounds per head daily at a feed cost of $10.01 per hundredweight of gain. The addition of 14 pounds of corn silage to this ration produced a gain of 1.85 pounds per head daily at a feed cost of $9.76 per hundredweight of gain. The addition of 28 pounds of wet beet pulp instead of 14 pounds of silage produced a daily gain of 1.91 pounds per head and at a feed cost of only $8.49 per hundredweight.

Ordinarily the addition of protein concentrates causes such a marked increase in gain that the feed cost per unit of gain is actually reduced. In one Colorado experiment the addition of 3 pounds of cottonseed cake to a ration of wet beet pulp, beet molasses, and alfalfa hay increased the daily gain on 3-year-old steers nearly 1 pound (1.54 to 2.48) per head daily and reduced the cost of gain nearly $2 per hundredweight ($11.98 to $10.08). Linseed cake did not prove as efficient as cottonseed cake in such tests. Each ton of cottonseed cake fed replaced 15.7 tons of wet beet pulp, 1 ton of molasses, and 2.8 tons of alfalfa. Even with the low values used of $1.50 per ton for pulp, $15 per ton for molasses, and $10 per ton for hay, the cottonseed cake showed a feed-replacement value alone equal to $66 per ton and in addition enhanced the value of the finished cattle 25 cents per hundredweight.

The Montana Station has obtained similar results from the use of cottonseed cake fed with beet byproducts to cattle.

Recent experiments at the Colorado Station indicate that in fattening calves on an average ration of 2.4 pounds of barley, 2.4 pounds of corn, 25 pounds of wet beet pulp, 7 pounds of alfalfa, and 0.02 to 0.03 pounds of mineral mixture, one half pound of cottonseed cake was better than 1 or 1½ pounds of cake, considering rate and economy of gain, sale price, and proceeds.

Barley fits well in the beet-growing rotation and has proved practically equal to corn when used in beet-byproduct rations containing a good variety of feeds. Barley fed in limited amounts with beet pulp does not have the tendency to cause the bloat which is characteristic of feeding it in large amounts with hay alone in the Northwest. It should always be coarsely ground or rolled for cattle.

For calves a good rule is to feed about 1 pound of barley for every 100 pounds the animal weighs along with 1 pound of some protein-rich concentrate, about 5 pounds of alfalfa hay, and a full feed of wet beet pulp, usually about 30 pounds. Older cattle having a greater capacity for wet beet pulp should do well on less barley in proportion to their weight.

Where there is a limited allotment of wet beet pulp and a limited supply of alfalfa hay, there is the problem of providing some cheap bulky feed for the fattening ration.

Colorado experiments show that corn silage fed mixed with wet beet pulp at the rate of one third silage and two thirds pulp produced more expensive gains than pulp alone but cheaper gains than a ration of grain, hay, and cottonseed cake. Although corn silage is neither as cheap nor efficient as wet beet pulp, it ranks next to pulp in low cost as a bulky succulent feed and can be used to advantage in supplementing a limited supply of pulp. Siloed beet pulp (89 percent water) is estimated to have about half the value of good corn silage.

While cull potatoes are less palatable than wet pulp, and calves will not do as well on a full feed of them, a mixture of two thirds pulp and one third cull potatoes has given as good results as a full feed of pulp.

There are several rations that find favor among cattlemen in the beet-producing areas where cattle are fattened. Some prefer to feed all of the wet or siloed pulp the cattle will consume, and a mixture of about 8 to 10 pounds of hay and straw finely chopped, 4 pounds of molasses, and 2 pounds of cottonseed cake per head. Experiments have proven that such chopping of good roughages generally does not pay. Others make a practice of feeding 5 to 10 pounds of grain per head and a full feed of wet or siloed pulp and hay. When the hay is fed whole, grain, molasses, and cake may be scattered over the pulp.

WET BEET PULP FOR SHEEP

Wet pulp is an excellent feed for fattening lambs, as it tends to increase gains and reduce digestive trouble and death losses. As a result of 6 experiments at the Colorado Station, it was found that 1 ton of wet beet pulp was equal to 115 pounds of shelled corn and 358 pounds of alfalfa hay in producing gain in fattening lambs. The statements relative to use of concentrates, legume hay, and oil-mill byproducts to supply protein and other nutrients in fattening cattle apply generally in the same degree to sheep. However, barley should be fed whole. Generally, the practice is to feed the hay first and then place the pulp on top of the remaining hay. In doing this, the pulp softens the coarse left-over stems, making them more palatable, inducing the lambs to clean up the pulp and hay refuse before the late-afternoon feed of hay.

On account of the bulky nature of wet beet pulp and the high nutritive value of its dry matter it may be used as a partial substitute for either grain or hay or both in fattening lambs. In addition, the use of it usually results in a greater quantity of dry matter being consumed than would be were it not fed. Often as much as one third to one half of the hay is replaced by wet pulp. Lambs should be started on about 1 pound of pressed pulp per day and may be increased to a full feed, about 6½ pounds, in 25 days. To get them on a full feed of grain requires about 30 days.

Some feeders prefer wet beet pulp for feeding sheep because the moisture in the pulp lessens the need of having water for them to drink. According to two experiments conducted by the Wyoming Agricultural Experiment Station, lambs that were not watered ate and gained slightly more, but the gains were a trifle less economical.

At the Belle Fourche Field Station, Newell, S.Dak., the advantages of adding a protein supplement such as cottonseed or linseed cake to a ration of alfalfa hay and pressed pulp are clearly shown in considerably larger gains and higher selling price. Eighty-three pounds of cake replaced 553 pounds of pulp and 276 pounds of hay.

In the intermountain region approximately 4 pounds of wet pulp is generally fed either in trough or through panels to lambs, it being estimated that 4 pounds of wet pulp replace 1 pound of alfalfa hay or one half pound of grain. Some sheepmen value wet pulp as a conditioner for bred ewes before lambing. After lambing, about 5 pounds of wet pulp, one half pound of grain, and 2 pounds of alfalfa hay make an excellent ration for producing a good flow of milk.

In Colorado, some feeders prefer feeding wet beet pulp in troughs while others feed wet pulp along the panel (fig. 7) and dried pulp (either plain or dried molasses pulp) in the troughs. In either case from 2 to 3½ pounds of wet pulp and one fourth of a pound of dried pulp are fed per animal at each of two feedings. The wet pulp is fed to the lambs early in the morning and is followed by a feeding of grain and hay. As the wet pulp is usually a cheaper source of dry matter than hay, it is the general practice to limit the hay to 1 pound per head daily and to full-feed grain and pulp in order to get rapid gains at a reasonable cost.

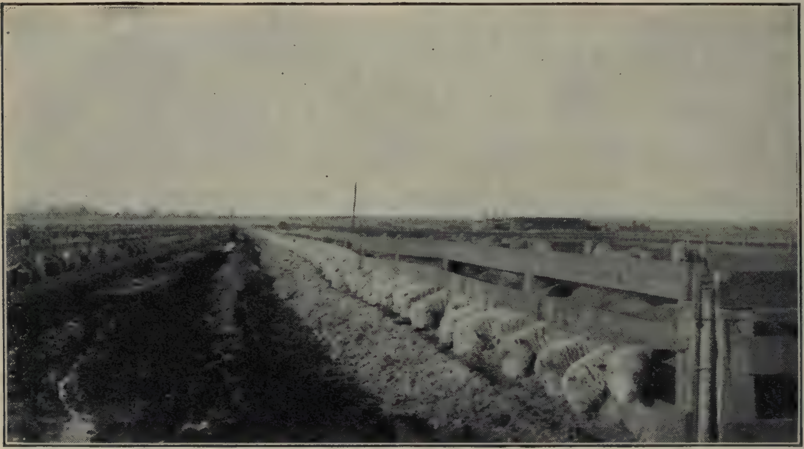

FIGURE 7.—Lambs feeding on beet pulp through panels.

WET BEET PULP FOR DAIRY CATTLE

Information on the feeding of sugar-beet pulp to dairy animals is available from two sources, namely, general feeding practices and experimental work. Much information on the feeding of wet sugar-beet pulp to dairy animals has been obtained from the general practices of dairymen located in close proximity to sugar factories. These dairymen have come to depend on sugar-beet pulp, largely because they found in this byproduct a valuable source of succulent feed for their dairy animals. Many of these dairymen grow only enough corn for silage purposes to insure an ample supply of succulent feed, since frequently the amount of pulp allotted them by the sugar company is insufficient to meet the requirements of their herds. The reports on the use of beet pulp in the main have been favorable.

According to the Colorado Agricultural College, beet pulp produces good milk when not fed excessively. Excessive feeding without proper supplements, such as bone meal and legume hays, may result in the production of weak calves because beet pulp is very low in lime, which is vital to the production of healthy calves. Three pounds of wet beet pulp is equal in feeding value to about 1 pound of silage or 1½ pounds of sugar beets for dairy cows. Its very low protein content makes it necessary to have a leguminous hay in the ration or some high protein concentrate, such as cottonseed meal. Wet beet pulp should not be fed in the barn because its odor may affect the milk. It is advisable to feed the pulp soon after milking, taking the cows away from the feed at least an hour before they are to be milked.

Experimental work recently conducted in feeding tests in which wet sugar-beet pulp and corn silage were compared is of interest. The Utah Agricultural Experiment Station has recently reported the results of a feeding trial extending over a 4-year period. In this trial two groups of cows were fed the following ration: The group that was fed wet beet pulp consumed on an average 68.1 pounds of wet pulp, 20.3 pounds of alfalfa hay, and 5.4 pounds of grain per head as a daily ration, and the group of cows fed corn silage consumed 32.1 pounds of silage, 20.9 pounds of alfalfa hay, and 4.5 pounds of grain per head per day. From this it will be noted that there was little difference in relative economy in hay consumption between the two rations used. It was found that 2.1 pounds of wet beet pulp with an average dry-matter content of 11.5 percent was required to replace 1 pound of corn silage with an average dry-matter content of 26 percent. The average daily production of milk per cow during the four winter periods was 23.5 pounds containing 0.77 pound of butterfat for the silage group, while the pulp group produced 27.9 pounds of milk containing 0.91 pound of butterfat or 4.4 pounds of milk and 0.14 pound of butterfat more per day than was produced per cow in the silage group. It is considered that this average difference of 18.7 percent in milk and 18.2 percent in butterfat in favor of the pulp-fed group of cows is not due to the different rations, but rather to the condition of the cows in the silage group. These cows carried calves for 0.15 day longer for each day they were in the experiment, and gained 0.16 pound more in weight per head per day than did those in the pulp group. The cost of producing 100 pounds of milk for the pulp-fed group of cows was slightly higher than for the group fed corn silage. This difference was due to the high tonnage of corn produced per acre; otherwise the cost could easily be reversed.

During the four summer periods there was no significant difference in milk and butterfat production between the corn-silage and wet-pulp groups, the same being likewise true of the health of the calves dropped by the two groups of cows. It was observed, however, that the cows in the pulp group developed what seemed to be a tenderness of the hind limbs and a tendency to lick board fences and at times to chew at sticks. No cause was assigned for this condition. This observation calls to attention the desirability of further experimentation with this class of feeds in various localities, looking toward the determination of desirable supplements such as minerals high in phosphorus or steamed bone which may correct any deficiency that may exist in the ration.

WET BEET PULP FOR HORSES AND SWINE

While 20 to 40 pounds of wet beet pulp may be fed to idle horses when properly supplemented with dry roughage, it should not be fed to work horses. The Utah Station reports that colts had constant access to pulp at a sugar factory for several years without any bad results.

Beet pulp is not extensively used in feeding swine. In an experiment carried on by the Utah Station 609 pounds of wet beet pulp fed at the rate of 12.3 pounds per head daily replaced 100 pounds of shorts in fattening pigs.

FEEDING DRIED PULP

The pulp-drying equipment of beet-sugar factories consists of slowly revolving drums in which the heat from furnaces is regulated in accordance with the quantities of wet pulp entering the drums. The dried beet pulp, which usually contains less than 10 percent of water, is usually bagged as soon as it comes from the drums, although at some factories a quantity is stored in bulk to supply the local trade. The yield of plain dried pulp produced ranges from approximately 4.5 to 5 percent of the weight of beets purchased. Frequently beet molasses is added to the dried pulp, and the pulp is then sold as dried molasses pulp.

The dried beet pulp and dried molasses pulp are popular feeds, since they can be stored under proper conditions for considerable periods without deteriorating and can be transported long distances, like many other kinds of feed. They can be used to advantage as bulky concentrates to lighten rations of heavy concentrated feeds. The amount being disposed of locally is increasing.

It has been shown that dried beet pulp has a much higher feeding value when fed mixed with corn or barley or fed with corn silage or corn fodder or cottonseed cake than when fed as a lone concentrate. Fed alone with alfalfa in three tests at the Colorado Station, it showed only 75 percent of the feeding value of corn; mixed equal parts with corn, it showed 97.8 percent of the value of corn. Both beet pulp and dried molasses pulp have more of a tendency to produce growth in a fattening ration than corn does.

Dried molasses pulp has about the same feeding value as dried beet pulp but is somewhat more laxative. It usually contains about 25 percent of beet molasses. For winter or spring feeding of livestock on the range, dried molasses pulp alone and cottonseed cake and dried molasses pulp have been placed on the market in pellet form for feeding on the open ground or on the snow, and to avoid loss by wind. Another advantage claimed for dried beet pulp when fed to livestock is the greater consumption of water. In a particular case where it was desirable to induce stallions to drink about midnight this result was obtained by feeding dried beet pulp as a part of the grain ration.

DRIED BEET PULP FOR BEEF CATTLE

As dried pulp is more bulky than corn or barley, it is less suited to getting a high finish than such grains. If pulp and corn are to be fed it is well to feed a larger proportion of the pulp early in the fattening period and more of the corn in the latter part. In comparing dried pulp and dried molasses pulp with oats for fattening steers, English investigators found them practically equal, but the pulp-fed cattle were more contented. While the fat from pulp feeding was slightly softer, there were no objections from the butchers and apparently no differences in the texture of the meat.

According to the Michigan Station, 10 pounds of dried beet pulp per 1,000 pounds of live weight is about the limit for cattle being fattened.

In fattening calves on barley and alfalfa hay at the Colorado Station, 4.3 pounds of barley and 20 pounds of siloed pulp gave slightly better results than 3.8 pounds of barley and 3.4 pounds of dried pulp. This indicates that 6 to 7 pounds of siloed pulp are equivalent to 1 pound of dried pulp. In a similar experiment, it required about 8 pounds of siloed pulp to equal 1 pound of dried pulp.

The Colorado Station also reports that 1 pound of dried beet pulp is equal to 1 pound of corn or 2.8 pounds of alfalfa hay for fattening 2-year-old steers. For the most satisfactory gains, both grain and dried pulp should be fed with legume hay.

According to findings of the Colorado station, a ton of dried molasses pulp when fed mixed half and half with corn replaces 1,665 pounds of corn and 640 pounds of alfalfa hay or has 95 percent of the feeding value of corn.

DRIED BEET PULP FOR SHEEP

In the West there have been heavy losses of lambs on a full feed of corn such as 1 pound per head daily. Such losses are greatly reduced by feeding a 50–50 mixture of dried molasses pulp and corn. Some men prefer to feed 3 parts of corn and 1 part of dried beet pulp, while others feed dried beet pulp with barley, using one third pound of dried pulp to 1 or 1¼ pounds of barley.

According to the Michigan Station, sheep prefer dried molasses pulp to plain dried pulp. This station has also reported that while both products compare very favorably with corn in feeding value they tend to produce more growth and less fat than corn.

At the Belle Fourche Field Station three experiments in fattening lambs showed that 100 pounds of dried pulp replaced approximately 110 pounds of barley when half barley and half dried pulp instead of all barley were fed with cottonseed cake and alfalfa hay. The substitution of dried pulp for half of the barley did not affect the rate of gain or the sale price.

At the same station the advantage of adding a protein supplement such as cottonseed or linseed cake to a ration of dried pulp and alfalfa hay was clearly shown. The cake-fed lambs gained much more per head (8 to 10 pounds) and sold slightly better than the lambs getting no cake. Averaging the three experiments, 68 pounds of cake reduced the feed requirements per 100 pounds of gain by 164 pounds of dried pulp and 253 pounds of hay. In other words, when 68 pounds of cake are as cheap as or cheaper than 164 pounds of pulp and 253 pounds of hay, the indications are that the purchase and feeding of the cake will be profitable.

The average of three experiments at the Scotts Bluff Field Station, Mitchell, Nebr., shows that in fattening lambs equal parts of corn and dried pulp, and corn alone, when fed with alfalfa hay are practically equal in value. As the proportion of dried pulp is increased above 50 percent, the rate of gain of the lambs decreases, and the quantity of feed required per unit of gain increases. At the same station, increasing cottonseed cake per 25 lambs daily from 2 to 10 pounds with 32 pounds of dried pulp increased the rate of gain and reduced the requirement per 100 pounds. When 8 pounds and 10 pounds were fed, the selling price rose from $6.75 to $7. With pulp $12, cottonseed cake $25, and alfalfa $7 per ton, it was profitable to feed more cottonseed cake.

DRIED BEET PULP FOR DAIRY CATTLE

Dried beet pulp or dried molasses pulp are extensively used in feeding dairy cattle. They may be fed either in dry form or moistened. Dried beet pulp soaked in about three times its weight of water makes a good substitute for other succulent feed. However, it is usually more expensive than silage. The soaked beet pulp is also valuable as a feed for high-producing cows. Frequently the grain requirement for such cows is so high that the necessary quantity cannot be fed without endangering their health. In such cases the quantity of grain may be kept at a safe level and the additional nutrients supplied by feeding beet pulp.

Some of the intermountain dairymen feed a one fourth dried molasses pulp and three fourths grain mixture consisting of oats and barley, the total amount of the mixture fed ranging from 4 to 12 pounds daily, depending on milk production. The milking cows are fed alfalfa hay at will, whereas the dry stock is fed hay and straw sprinkled with 1 to 2 pounds of molasses mixed half and half with water. When fed dry, it is customary to mix the pulp with the grain in the proportion of 3 parts grain to 1 part of dried pulp and feed at the rate of 1 pound of this mixture to 4 pounds of milk produced. Many dairymen prefer dried molasses pulp which they feed with grain, making a mixture of 1 pound of dried molasses pulp to 3 pounds of the grain (which frequently consists of oats and barley), the total amount of the mixture fed ranging from 4 to 12 pounds per head daily, depending on milk production. These dairymen are of the opinion that dried molasses pulp is equal to grain when fed in a ration. The milking cows are fed alfalfa hay at will, whereas the dry stock is fed hay and straw sprinkled with 1 to 2 pounds of molasses diluted one half with water.

There is a prejudice among dairymen against pulp that is dark-colored, which seems to be unwarranted as the dark color is due to the addition of molasses, and, as experiments show that both plain dried pulp and dried molasses pulp have practically the same feeding value, the discrimination is not justified. While the dried molasses pulp commonly contains 20 to 25 percent of molasses, some dairymen prefer pulp with as much as 40 percent of molasses. Ordinarily one should use the pulp that can be bought most cheaply.

The Ohio Experiment Station, in reporting the results of a series of tests in feeding cows where corn silage and dried beet pulp soaked and flavored with molasses had been used as a corn-silage substitute, concluded that while the groups of cows fed dried molasses pulp showed an increase of 9.3 percent in milk production and 3.4 percent in butterfat, on the basis of feed consumed, the dried molasses pulp ration cost sufficiently more than the corn-silage ration to make feeding it uneconomical when corn silage could be produced at moderate cost.

In a test conducted cooperatively by the Division of Dairy Cattle Breeding, Feeding, and Management, Bureau of Dairy Industry, and the Utah Experiment Station, the results show that when 100 pounds of dried molasses pulp replaced 50 pounds of barley and 50 pounds of wheat bran in the grain mixture there was no significant decrease in production of milk. The cows were fed as much alfalfa as they would consume; corn silage was fed on the basis of 2½ pounds per day per 100 pounds live weight of the cows. Grain was fed on a basis of 1 pound per day for each pound of butterfat produced in 7 days. All cows had access to salt and steamed bone meal fed in boxes under the shed. The average daily milk production of the cows when fed the barley and wheat-bran mixture was 27.6 pounds per day, and 26.5 pounds of milk were produced when cows were fed a mixture of barley, wheat bran, and dried beet pulp. It is indicated by this test that with dairy cows dried molasses pulp is equal to a mixture of chopped barley and wheat bran, equal parts by weight, for milk production.

DRIED BEET PULP FOR HORSES

While dried beet pulp alone is not palatable to horses, as much as 5 pounds per head may be mixed with molasses or other well-liked feeds and be included in the ration to good advantage. As beet pulp is low in protein, the ration should include some feed which is relatively high in protein.

MOLASSES

In the manufacture of beet sugar the solution of sugar extracted from the sliced raw beets is evaporated until a sirup is formed, and the maximum amount of sugar has been crystallized. Then the crystals are separated from the mother liquor by centrifuging. There is still much sugar remaining in the mother liquor, which is reworked several times to recover as much of the crystallized sugar as can profitably be extracted in this manner. The residue is called molasses. In those beet-sugar factories where the Steffens process is used, the molasses is "limed" to extract more sugar. This is known as Steffens or foreign-discard molasses. There is still another process, in which barium is used instead of lime, by which the recovery of sugar from the Steffens molasses is carried on still further. The residue from this process, which is known as final discard, is much less than that from the Steffens process, and compares very favorably in feeding value with Steffens molasses.

The final-discard molasses has a bitter taste. In addition to its customary quota of sugar, it contains from 10 to 15 percent of raffinose, which increases its carbohydrate content accordingly. In recent lamb-feeding tests at the Colorado Station this final-discard molasses proved more palatable than any of the others, including cane.

Beet molasses, while of great value industrially in the manufacture of alcohol and in the manufacture of yeast for human and animal consumption, is used chiefly at present in livestock feeding. It is also very useful as an appetizer in poison-bran mashes for controlling certain insect pests. The molasses insures the retention of moisture and the proper crumbling consistency of the mash. Beet molasses is classed as a concentrate, having generally less than 20 percent of moisture. It is sold either in tank-car lots or in barrels. Farmers near the factories may effect a saving by furnishing their own containers. Some use tank wagons or trucks. Metal containers are generally preferred, as there are no seams through which the molasses can leak.

The composition of molasses varies greatly, depending not only upon the source and character of the beets and the control of the process at the factories at which it is produced, but also upon different periods of the sugar campaign. Table 2 gives the composition of molasses not "Steffenized" in comparison with cane molasses, barley, and corn. The carbohydrates consist mainly of sugars (sucrose plus approximately 0.5 percent of invert sugar). In the latter part of the factory operations there may be up to 1 percent or more of the sugar known as raffinose in the molasses. In some factories, the Steffenized molasses may contain an even higher percentage of carbohydrates. The mineral matter consists of sulphates, chlorides, nitrates, and phosphate. Compounds of potassium constitute from one third to one half of the total mineral matter.

TABLE 2.—*Analysis of beet molasses, cane molasses, barley, and corn* [1]

Kind of feed	Water	Ash	Crude protein	Carbohydrates		Fat or ether extract
				Crude fiber	Nitro-gen-free extract	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Beet molasses	20.8	10.6	9.1	--------	59.5	--------
Cane molasses	24.0	6.8	3.1	--------	66.1	--------
Barley	9.6	2.9	12.8	5.5	66.9	2.3
Corn	12.9	1.3	9.3	1.9	70.3	4.3

---

[1] Compiled by the Cereal Section, Food and Drug Administration, and the Animal Husbandry Division, Bureau of Animal Industry, U.S. Department of Agriculture.

MOLASSES FOR BEEF CATTLE

On account of its unusual palatability, molasses usually adds more to a ration than its composition would indicate. Beet molasses should be introduced gradually into fattening rations, starting with about one half pound per head daily, in order that the digestive system may become accustomed to the salts which it contains. In hand-feeding, the molasses is usually sprinkled on the wet beet pulp or is spread in the trough and covered with grain. In self-feeding, it should never be fed warm.

There is considerable to be said in favor of feeding molasses on the coarser and less palatable roughages that farmers usually have, as it is an efficient method of using material which might not otherwise be eaten. However, molasses must be fed with care in hot weather, the amount fed to large cattle being reduced from 3 or 4 pounds daily to 1 pound, and corresponding reductions made for other livestock. Some feeders prefer to self-feed molasses, allowing the animal free access to the molasses at all times (fig. 8). In the case of 3- to 4-year-old cattle as much as 8 to 9 pounds per day may be consumed during cold weather without bad effects.

In fattening steers at the Colorado Station, 100 pounds of beet molasses replaced 79 pounds of barley, 77 pounds of corn silage, and 33 pounds of alfalfa hay in one experiment and 47 pounds of barley, 125 pounds of sunflower silage, and 47 pounds of alfalfa hay in another. Averaging several experiments in fattening cattle, the Colorado Station concludes that beet molasses when fed in limited amounts has about 88 percent of the feeding value of corn, pound for pound.

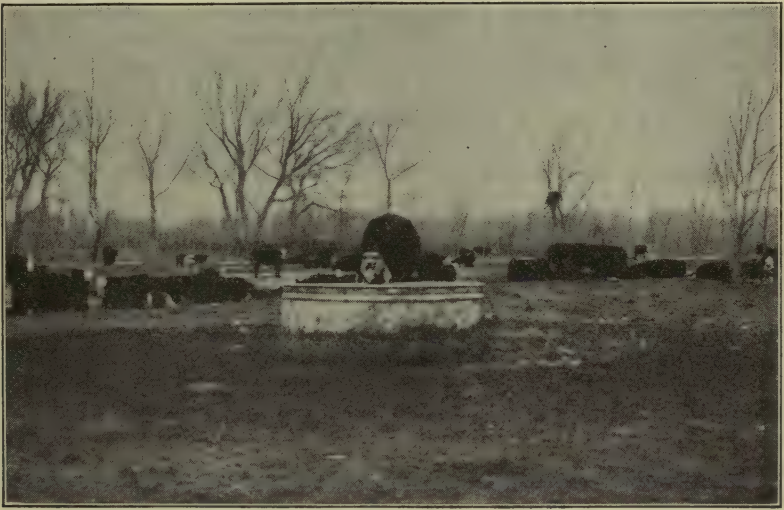

FIGURE 8.—Steers having free access to beet molasses. They will eat as much as 6 pounds of molasses per head per day without bad aftereffects.

MOLASSES FOR SHEEP

Beet molasses has about 85 percent of the feeding value of grain when fed with grain and alfalfa to lambs. The Colorado Experiment Station states that greater efficiency for feeding beet molasses is indicated when smaller amounts are fed. In hand-feeding, the molasses is usually spread from the buckets in the grain troughs and then covered with grain, so that the lambs get a small amount of molasses with each mouthful of grain. Wasting the molasses is thereby avoided, as the lambs are kept much cleaner than where molasses is spread over the grain.

Beet molasses may also be mixed with water and spread over alfalfa or other roughages, or it may be used as a part of a ground-hay mixture. In such a mixture there is about 20 percent of molasses. Some feeders prefer to self-feed molasses, in which case the lambs should be gradually accustomed to it. It is better to hand-feed the lambs for 4 or 5 weeks with the grain and molasses mixture before starting self-feeding on molasses. Lambs will eat as much as 1¼ to 1½ pounds of molasses daily when self-fed. However, the wool is apt to get very dirty.

Lambs hand-fed on grain and alfalfa are generally started on one tenth of a pound of molasses daily, which is gradually increased to one fourth pound at 15 days and one half pound in 30 to 40 days.

A 4-year comparison of shelled corn and alfalfa hay with shelled corn, beet molasses, and alfalfa hay for fattening lambs at the Colorado Station showed slightly greater daily gains (7 percent) and a saving of 59 pounds of corn and 74 pounds of alfalfa hay for each 100 pounds of molasses fed. Two experiments conducted by the Wyoming Station showed that the addition of one fourth of a pound of molasses daily to a ration of corn and alfalfa increased the rate of gain 10 percent, and 14 percent when added to a ration of barley and alfalfa.

However, at the Belle Fourche Field Station in fattening lambs the addition of about 0.4 pound of molasses per lamb daily to a full ration of pressed pulp and alfalfa hay did not materially affect the rate of gain or sale price. As it replaced only an equal weight of pressed pulp and half its weight of alfalfa hay, its use was not economical during the winters of 1927 to 1931, inclusive. In three experiments at the Huntley Field Station the addition of molasses (about one fourth of a pound per head) to a ration of barley, cottonseed cake, wet pulp, and alfalfa hay increased the cost of gain and cut the rate of gain and profits. Therefore, it is concluded that the addition of molasses to a fattening ration containing considerable wet pulp is not desirable.

Frequently questions are asked by feeders of livestock concerning the relative feed value of beet molasses and cane molasses. At the Colorado Station tests conducted with cane versus beet molasses for the feeding of lambs show that a ton of discard (Steffens) molasses replaced 1,043 pounds of shelled corn, but 55 pounds more hay were required as compared with cane molasses, which replaced 807 pounds of shelled corn but required only 8.5 pounds more hay. Several lamb-feeding experiments conducted at the Washington and Iowa agricultural colleges have shown that sugar-beet molasses is fully equal if not superior to cane molasses for fattening cattle and lambs.

MOLASSES FOR DAIRY CATTLE

The use of molasses on hay is endorsed by many of the dairymen of the intermountain region who feed about 2 to 3 pounds of molasses per cow per day sprinkled over the alfalfa and other roughages. When molasses is fed in these amounts the dairymen estimate that it has about 80 percent of the value of grain, pound for pound. When molasses is fed to breeding stock care must be exercised not to exceed 3 pounds daily. Some farmers mix molasses and water half and half in a large tank, because such a mixture will not freeze in coldest weather, always flows, is less sticky, and is easier to handle.

MOLASSES FOR HORSES AND SWINE

As a horse feed, beet molasses is not so satisfactory as cane molasses. The presence of certain salts stimulates the action of the kidneys and bowels of the animals fed. Because of this action it is not desirable to exceed 5 pounds of beet molasses in the daily ration. Like cane molasses, it is a carbohydrate concentrate, very palatable and suitable for feeding as part of a concentrate in the ration that also includes a protein feed.

Molasses is not used much as a feed for hogs and should be mixed with concentrates when it is fed. Only a few experiments have been made with this feed for hogs, and they show a very wide variation in results, some being as low as about 60 percent of the feeding value of corn. In an experiment at the Utah Experiment Station, pigs weighing 139 pounds were fed for 48 days on an average ration of shorts 3 pounds, beet pulp 9.4 pounds, and beet molasses 4.4 pounds, and gained 75 pounds. Another lot fed 7.6 pounds of shorts daily gained 83 pounds per head.

Considerable caution should be practiced in feeding molasses to hogs. Feeding molasses to young pigs results generally in serious digestive disorders, and if it is fed to sows before farrowing the litters are apt to be weak. Practice seems to indicate that hogs should not receive any molasses until they weigh 125 pounds or more, and that then they should not be forced to eat it by mixing with other feeds, but allowed to get it at will from the trough. When fed to older hogs at the rate of 1 to 1½ pounds per day, molasses generally has somewhat less value than the same quantity of shelled corn.

MISCELLANEOUS BYPRODUCTS

MOTHER BEET ROOTS

Sugar-beet seed is now grown in several of the western and southwestern sections of the United States. After the seed is harvested in July, the mother beet roots that remain in the ground may be used for feed. These roots have considerable feed value as their sucrose content ranges from 5 to 8 percent or more. They should be plowed out of the ground and placed in a trench silo and fed as needed, or if desired they can be cut up in small pieces and ensiled. Such silage has a fattening value comparable to beet-top silage. Another practice followed is that of plowing out the roots, so that they will be readily available and then permitting livestock to graze on them. However, roots left exposed to the weather in this manner dry out rapidly and become very hard and fibrous, in which condition they may prove dangerous to livestock.

BEET TAILS

In transferring beets to and from the trucks or wagons at the dumps and in the storage bins and in various conveyors, some breakage of the "tails" results. The tails accumulate usually in catch basins and traps in the flumes of the factory. In addition, some beet tops that are caught by the automatic trash catcher in the flumes are mixed with the tails. From 2 to 4 tons or more of this refuse, depending on the slicing capacity of the factory, accumulates daily. This byproduct may be fed fresh or siloed. It has practically the same feeding value as fresh beet tops or beet-top silage.

LIME CAKE

In the process of extracting sugar from the sugar beet, and later, in reworking the molasses to extract more of the sugar, large quantities of burned limestone of very high calcium-carbonate content are needed. The amounts used vary with the condition of the beets, the efficiency of the factory, and according to whether or not the Steffens process is used. If this process is used, the amount of burned lime required is increased considerably. The range varies from 4 to 6 percent or more of limestone used to the weight of the beets sliced. Using as a basis 8,000,000 tons of beets sliced and assuming that the consumption of limestone is 5 percent of the beets sliced, this would mean that the equivalent of at least 400,000 tons of dry lime cake would be produced when a crop of such size is processed. This lime cake (also known as factory lime, waste lime, filter press cake, and lime sludge) consists largely of calcium carbonate, contains some organic matter, and in its dry state compares favorably with the ground limestone sold for agricultural use. While some of this lime cake may be disposed of as sewage, the more general practice is to discharge this byproduct from the factory into large pits or settling basins from which it is removed periodically. In humid areas this byproduct may be placed in large piles to facilitate drainage and drying, and after a short time it is ready for shipment or for local use.

There are present in lime cake small amounts of phosphoric acid, nitrogen, and potash. Since lime cake is very finely ground it corrects the acidity of the soil more rapidly than the coarser ground limestone commonly sold for this purpose. Favorable results have been reported from its use in growing legumes, especially alfalfa, sweetclover, and red clover. The amount of lime cake which should be applied varies with the need for lime in correcting the acidity of the soil.

Lime cake has also been used with success on soils that have become compacted, as it tends to break up the soil and give it a granular structure. Whether used for improvement of soil texture or for correcting the soil reaction, lime cake should be applied broadcast on the field, either during the winter months or immediately prior to the seeding of legumes. In some factory districts where the value of the lime cake has been recognized, considerable quantities of this byproduct are sold at a very nominal cost per ton.

Lime cake has also been found to be of considerable value in certain areas when applied with irrigation water on reclaimed lands in close proximity to the factory, resulting in noticeable improvement in the soil condition and in increased yields of the succeeding crop. Because of the frequently demonstrated danger of spreading the sugar-beet nematode by this manner of disposal (occasioned by washing the nematode from the beet into the waste water at the factory) this method of spreading lime, in areas of known sugar-beet nematode presence, should be used with great caution if infestation of the land is to be prevented.

RATIONS AND FEED MIXTURES CONTAINING SUGAR-BEET BYPRODUCTS

In using a ration containing sugar-beet byproducts it is important to keep in mind that calves should be started on about one half pound per head daily of such concentrated feeds as cottonseed cake, molasses, and 2 or 3 pounds of grain or dried pulp, and gradually increased to a full feed in about 30 days. Larger cattle may have more in proportion to their greater weight. However, older cattle are often fed a larger proportion of roughages, especially during the early part of the feeding period. The maximum quantity of concentrates per day fed during the latter part of the feeding period is usually about one third more than the quantities given in these suggested rations, which are an average for the whole period. The roughages and bulky feed such as wet pulp are full-fed from the beginning and are reduced toward the end of the fattening period. The same applies to sheep, except that they should be started on about an ounce of such concentrates as cottonseed cake and molasses and one fourth of a pound of grain or dried pulp.

RATIONS FOR BEEF CATTLE AND LAMBS

On the basis of experiments conducted at different experiment stations the following rations for fattening beef cattle and lambs are suggested:

BEEF CATTLE, COLORADO AGRICULTURAL EXPERIMENT STATION

Beef calves fed 200 days	*Pounds*
Wet pulp	30
Beet molasses	2.5
Cottonseed cake	1.5
Alfalfa hay	14
Yearlings fed 190 days	
Wet pulp	80
Beet molasses	3
Cottonseed cake	3
Alfalfa hay	8
Beef calves fed 90 to 120 days	
Beet tops	14
Ground barley	2
Pressed pulp	14
Cottonseed cake	.5
Alfalfa hay	5
Yearlings fed 190 days	
Corn silage	13
Dried molasses pulp	11
Cottonseed cake	2
Alfalfa hay	7

2-year-olds fed 160 days	*Pounds*
Wet pulp	90
Beet molasses	3
Cottonseed cake	2
Alfalfa hay	10
3-year-olds fed 125 days	
Wet pulp	90
Beet molasses	4
Cottonseed cake	2
Alfalfa hay	10
2-year-olds fed 110 days	
Beet top silage	21
Dried molasses pulp	7
Cottonseed cake	2.5
Alfalfa hay	12
2-year-olds fed 110 days	
Dried molasses pulp	10
Cottonseed cake	2.5
Alfalfa hay	13

LAMBS, BELLE FOURCHE FIELD STATION

	Pounds
Dried pulp	1.2
Alfalfa hay	2.1
Pressed pulp	6.0
Cottonseed cake	.2
Alfalfa hay	2.3
Dried pulp	.6
Barley	.6
Cottonseed cake	.2
Alfalfa hay	1.8

	Pounds
Dried pulp	1.0
Linseed cake	.2
Alfalfa hay	2.0
Pressed pulp	6.0
Alfalfa hay	2.4
Pressed pulp	5.6
Molasses	.4
Alfalfa hay	2.2

LAMBS, HUNTLEY FIELD STATION

	Pounds
Barley	1.0
Cottonseed cake	.2
Molasses	.3
Wet pulp	6.0
Alfalfa hay	1.5
Oats	1.1
Wet pulp	6.5
Alfalfa hay	1.9

	Pounds
Barley	1.1
Beet tops	2.3
Alfalfa hay	1.6
Barley	1.1
Wet pulp	5.8
Bean straw	1.3
Beet tops	1.8

RATIONS FOR DAIRY COWS

Dairy cows should be fed as much roughage as they will consume. The ration may include a moderate quantity of beet tops, wet beet pulp, or corn silage. Thirty pounds of fresh green beet tops or beet-top silage, 15 pounds of dried beet tops (cured and stacked), 50 pounds of fresh or ensiled wet pulp, or 30 pounds of corn silage is a desirable quantity to feed, per 1,000 pounds live weight, daily. Beet molasses not to exceed 3 pounds per 1,000 pounds live weight daily may be fed either in the grain mixture or sprinkled over the hay to render it more palatable. Ten or more pounds of dried beet pulp can be safely fed per cow per day. This may be fed dry as a regular ingredient of the grain mixture or fed after being soaked in 2 to 3 times its weight of water for several hours, to supplement the regular grain mixture. The use of dried beet pulp in the ration is thought to be desirable for high-producing cows being fed large quantities of grain.

These recommendations represent about the maximum quantities of beet pulp and beet molasses that it is desirable to use in grain mixtures. The quantity of grain to feed will vary with the quantity and quality of milk produced and the quantity of roughage consumed. Enough grain should be fed to maintain the milk flow and keep the cow in good condition. Cows producing medium or small quantities of milk and consuming large quantities of roughage need little or no grain. Cows producing large quantities of milk and consuming medium or small quantities of roughage will require considerable grain.

In regions where a good quality of alfalfa hay is available and where the cost of nutrients in dried beet pulp is lower than the cost of nutrients in grains, it has been found that alfalfa hay and the dried pulp make a satisfactory ration without the addition of grain.

DAIRY-FEED MIXTURES UTILIZING SUGAR-BEET BYPRODUCTS THAT ARE ADAPTED TO VARIOUS ROUGHAGES

Suggested grain mixtures with which different kinds and combinations of roughages are used are listed below.

Mixtures containing 11 to 12 percent total protein to be fed with alfalfa or other legume hay alone

Mixture no. 1:	Pounds
Dried beet pulp (plain or molasses)	400
Ground corn, oats, or barley	200
Wheat bran	200

Mixture no. 2:	Pounds
Molasses	100
Dried beet pulp (plain)	300
Ground corn, oats, or barley	200
Wheat bran	200

Mixtures containing 13 to 14 percent total protein to be fed with alfalfa hay and fresh or dried beet tops, beet-top silage, or fresh or ensiled wet pulp

Mixture no. 3 (feed with beet tops):	*Pounds*
Dried beet pulp (plain)	200
Ground corn, oats, or barley	200
Wheat bran	400

Mixture no 4 (feed with wet pulp):	*Pounds*
Molasses	100
Ground corn, oats, or barley	300
Wheat bran	400

Mixtures containing 15 to 16 percent total protein to be fed with alfalfa or other legume hay and corn silage; or mixed hay alone

Mixture no. 5:	*Pounds*
Dried beet pulp (plain or molasses)	300
Ground corn, oats, or barley	200
Wheat bran	200
Cottonseed meal	100

Mixture no. 6:	*Pounds*
Molasses	100
Dried beet pulp (plain)	200
Ground corn, oats, or barley	200
Wheat bran	200
Cottonseed meal	100

Mixtures containing 18 to 20 percent total protein to be fed with mixed hay and corn silage

Mixture no. 7:	*Pounds*
Dried beet pulp (plain or molasses)	300
Ground corn, oats, or barley	200
Wheat bran	100
Cottonseed meal	200

Mixture no. 8:	*Pounds*
Molasses	100
Dried beet pulp (plain)	200
Ground corn, oats, or barley	200
Wheat bran	100
Cottonseed meal	200

Mixtures containing 22 to 24 percent total protein to be fed with nonleguminous roughage, with or without corn silage

Mixture no. 9:	*Pounds*
Dried beet pulp (plain or molasses)	300
Ground corn, oats, or barley	100
Wheat bran	100
Cottonseed meal	300

Mixture no. 10:	*Pounds*
Molasses	100
Dried beet pulp (plain)	200
Ground corn, oats, or barley	100
Wheat bran	100
Cottonseed meal	300

In these grain mixtures, wheat, kafir, speltz, or hominy feed may replace part or all of the corn, oats, or barley. Linseed meal, peanut meal, or soybean meal may replace part or all of the cottonseed meal.

Using these mixtures as guides, the feeder of dairy cattle should work out a mixture that will be most economical under his conditions. The following rules furnish a guide for feeding grain or other concentrates (usually in the form of a grain mixture) to dairy cows, under most circumstances:

> Feed a grain mixture in the proportion of 1 pound to each 3 to 4 pints or pounds of milk produced daily by the cow; or 1 pound of grain mixture for every pound of butterfat that the cow produces during the week.
>
> Feed all the cow will respond to in milk production. When she begins to put on flesh above normal weight, cut down the grain mixture.

These mixtures for milk cows are also suitable for the feeding of yearling heifers. Heifers will consume proportionately less according to their weight.

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FARMERS' BULLETIN No. 1719

IMPROVING *the* FARM ENVIRONMENT FOR WILD LIFE

1862 1889

AS FARMS REPLACE virgin lands, whether forest or swamp, marsh or prairie, conditions affecting wild life are revolutionized. Some creatures, especially the larger ones, disappear. Others are benefited, at least during the earlier stages of agriculture, and increase in numbers. This is true of nearly all birds up to the size of the crow and of mammals to that of the rabbit. As agriculture becomes more intensive, however, and woods are cut down, hedgerows eliminated, and rough nooks here and there brought under cultivation, conditions become unfavorable for the smaller forms of wild life.

Uniform mature forest, uniform swamp, or marsh, or prairie—each harbors only a limited fauna. Pioneer agriculture—partially clearing and draining the country, breaking some soil, leaving other idle—diversifies conditions and permits increase in both variety and abundance of wild life. Intensive cultivation, however, brings another kind of uniformity, and this is a uniformity of barrenness, so far as wild life is concerned.

When nearly all the land on a large area is cultivated and practically all tree and shrub growth has been eliminated, agriculture has certainly been intensified to its own disadvantage. Then comes the need for encouraging the presence of wild life, a thing eminently worth doing for several reasons. Wild life is an asset to the farm, for the services of birds and other animals as insect destroyers, for the dollars and cents value of fur animals and game, and for the interesting and inspiring presence of the wild creatures and of the vegetation required to harbor them. Moreover, the "wild farming" of game is a fascinating activity.

This bulletin does not apply to conditions on all farms, and not necessarily to all parts of any one farm, but wherever an increase in the abundance of farm wild life is to be encouraged (and this should be far more general) the recommendations here set forth will be useful.

Washington, D.C. January 1934

IMPROVING THE FARM ENVIRONMENT FOR WILD LIFE

By Wallace B. Grange, formerly *cooperative agent*, and W. L. McAtee, *principal biologist, in charge Division of Food Habits Research, Bureau of Biological Survey*

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INTRODUCTION

NEARLY EVERY FARMER delights in the lusty whistle of bobwhite from a nearby post, the cheerful song of the meadowlark from the hay meadow, the rapid scolding calls of the killdeer as it swings about overhead, and the songs of many other birds, which he deems his friends and for which he invents picturesque names. Almost every farmer uses thoughtful care in protecting the homes of birds and animals, often taking great care to avoid destroying some tiny nest. No group of people more enjoys contact with living things than do farmers, nor is there any group from whom an appeal for wild-life protection will receive heartier response.

It is in the farmer's power to increase vastly the wealth of interesting creatures which, by sharing his property, bring him color, song, and sport. Most farmers find in this mere companionship sufficient justification for conscious effort toward the increase of wild life, but they need not forget that profits also are involved. Many of the wild creatures, for instance, are definitely allied with him in his battle against insect enemies, and others furnish salable recreation. Since, therefore, there are economic as well as esthetic factors concerned, the deliberate encouragement of many forms of wild life may be recognized as sound agricultural practice.

Despite their general interest, however, few farmers fully realize how directly every farm activity affects wild life. From dawn to dusk of each day the farmer's chores tend, each in its way, to make his premises a better or a worse home for feathered and furred creatures. The chopping down of a dead tree may mean death to a den of lively squirrels; the pasturing of a wood lot may eliminate a covey of quail; and the use of silos, the storage of manure, the drainage of marshlands, and many other parts of the farm routine may react profoundly upon the lives of songbirds, game birds, and fur animals.

Farm practice often can be modified so as to benefit wild things and yet in no way interfere with agricultural objectives. In fact, desirable bird and animal life on the farm may be greatly encouraged and multiplied by even minor modifications of agricultural usage. Nearly all farmers are interested in how this can be accomplished.

Wild-life management, particularly game management, is something essentially different from mere protection and preservation. Game management is a branch of agriculture, whereas preservation is much more a function of park and sanctuary administration. Preservation seeks to hold what there is, a laudable purpose, but one too frequently implying passive acceptance of present conditions rather than active efforts to better them. No farmer is interested merely in preserving his seed corn. No more need he be interested in preserving only a seed stock of game when he can, if he will, vastly increase and utilize it.

Furthermore, in reality it is not the lawmaker but the farmer who determines whether game may or may not be taken. If the farmer destroys the environment and with it the game, no one can take game even if there are privileges under the law. If game is present the farmer may permit hunting or he may prevent it by insisting on observance of trespass laws.

Although under the prevailing laws of the United States the farmer does not own the game, he nevertheless controls it, and without his active interest in its increase the hunting public and the lawmakers are powerless. It is evident that the millions of hunters in this country cannot be accommodated upon public property even by the most heroic efforts of game commissions in establishing public hunting grounds at great expense. By and large, the public must use the ordinary farm for its excursions after rabbits, squirrels, pheasants, and quail. To insure the continuance of that privilege it is incumbent upon sportsmen to observe every courtesy toward farmers upon whose lands they may have the privilege of hunting and to conduct themselves in accordance with the Golden Rule.

To make the farm fully productive of game is an agricultural process; use of the farm by the public, therefore, in harvesting the game crop demands recognition of costs assumed by the farmer in maintaining and paying taxes upon game coverts and in his donating a share of his other crops as food for wild life. Recognition of the financial aspect of the problem does not sordidly transmute the recreational value of wild life into gold or dollars; it merely faces the fact that practical efforts are necessary in the preservation and increase of game and wild-life environments on farms and that constructive labor merits reward.

The purpose of this bulletin, then, is to discuss how the farmer may encourage desirable wild creatures upon his lands, particular reference being made to game species, and also to consider what returns may compensate him for altering his premises and policies in favor of game and other wild things to a greater extent than would be justified as good agricultural practice if there were no compensation. Attention is given to what may be termed the indirect economic benefits resulting from the encouragement of wild life, as well as to the more direct forms of return.

With regard to lands taken out of agriculture and so-called marginal lands, this publication points out a use that can be widely adopted with benefit both to the farmer and the public; namely, production of revenue-yielding wild life. Marginal lands are not restricted to arid, rocky, or other generally nonagricultural regions. On the contrary they are present to some extent on most farms. Creek and ditch banks, rough spots, nooks where fences or other obstacles render cultivation impracticable, and other areas not being used may be devoted to wild life. If treated as suggested herein these areas will produce supplemental crops—fur and game—that may be the means of increasing farm income (pp. 58 to 60).

The recommendations here made do not apply to all farms and not necessarily to all parts of any one farm, but they do apply to areas where increase of wild life is recognized as desirable—and these should be far more extensive than at present. Some farming practices recommended differ from the "clean cultivation" ordinarily considered essential on all farms, but it must be recognized that clean cultivation and game do not go together. Wherever the presence of wild life is to be encouraged throughout a farm or on special parts of it, the practices here recommended are applicable.

REPRODUCTIVE CAPACITY OF WILD LIFE

The most important natural factor bearing upon wild-life management is the amazing reproductive capacity of living things. Many interesting calculations have been made to show in how surprisingly few generations, if unchecked, the cod would fill the seas, or the house fly, the rat, or some other creature would overrun the earth. Applied to game species on the farm, such calculations show that if a pair of cottontails, for instance, had complete success in rearing two litters of 6 young each season, there would be (assuming an even division of the sexes and no fatalities) 98 rabbits the second year, 686 the third, 4,802 the fourth, 33,614 the fifth, and so on. If a pair of quail had one brood of 14 chicks each season, there would be 128 birds the second year, 1,024 the third, 8,192 the fourth, 65,536 the fifth, and so on.

Thus, to aid efforts to increase wild life, there is available a reproductive force almost explosive in its intensity. Unchecked, there would soon be more quail, more rabbits, more of everything than the environment could support. Each kind of wild life, plant or animal, is trying to do the same thing; that is, to increase and spread indefinitely. Like the trees in a wood, however, in reaching for their place in the sun, the various groups overlap; the overlapping parts obliterate each other; and none attain complete domination. Man can do some planting or pruning, achieve some additions or eliminations, in Nature's realm, so as to favor desired groups at the expense of the undesired; this is the essence of wild-life management.

RELIEVING CHECKS UPON THE INCREASE OF WILD LIFE

Normally the increase of wild life is checked by natural wastage, by weather and accident, by predators, parasites, and diseases, and possibly at times by thirst or hunger; in other words, by pressure of other elements in the environment. To some degree we can reduce this pressure, and to the extent that we succeed we shall be rewarded by a more than normal increase in numbers of the groups we favor.

If not generally understood and accepted before, it was made clear in the report[1] on the cooperative quail investigation, directed by the Bureau of Biological Survey in southern Georgia and northern Florida from 1924 to 1929, that the most effective as well as the most economical way of increasing the population of a game species is by improving its environment. Providing more food and better cover and lessening the pressure of natural checks result in an immediate increase in the game.

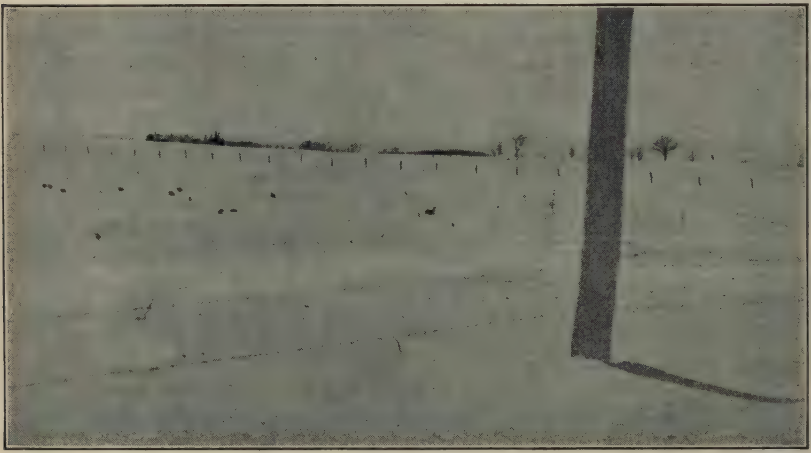

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FIGURE 1.—The minimum in game cover and food. Hungarian partridges picking at the last of the available weed seeds in a locality almost devoid of winter cover. These birds had to be winter-fed. There were large losses in country of this type when feeding was not carried on.

COVER FOR WILD LIFE

Cover is anything that provides a favorable retreat for wild life or offers it shelter or protection. Game cannot exist without suitable cover. Some species, the cottontail rabbit for instance, are so adaptable that they occur in many types of cover, ranging from grassy back yards of city dwellings to brier patches, and from northern humid forests to the semideserts of the Southwest. Other species, for example the prairie chicken, are less adaptable, occurring only where there are extensive marshes or grasslands. Deer and other larger animals require vast areas of suitable cover; while quail, on the other hand, may be accommodated by a single thicket or brushy fence row. Figures 1 to 3 illustrate, in order, almost total absence of cover, deficient cover, and satisfactory cover—all in farm environment. Table 1 shows the environment needed by some of the more common upland game birds and by rabbits and squirrels.

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[1] The Bobwhite Quail: Its Habits, Preservation, and Increase. New York, 1931.

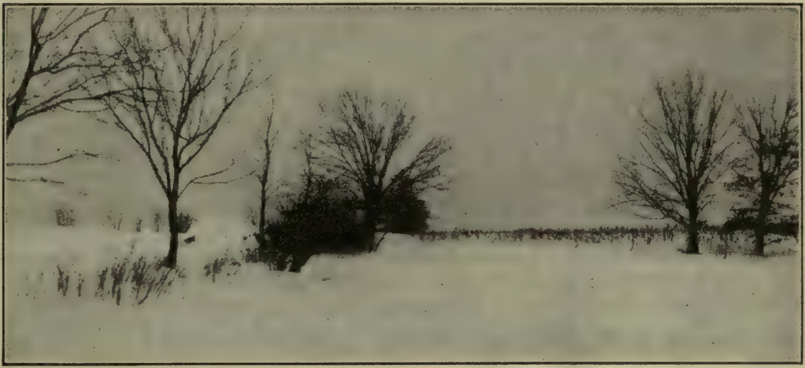
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FIGURE 2.—Deficient bobwhite cover, which could be made satisfactory by improving the hedgerow. The standing corn in the background, although used by both cottontails and quail, is so distant from cover that the game is much exposed to danger.

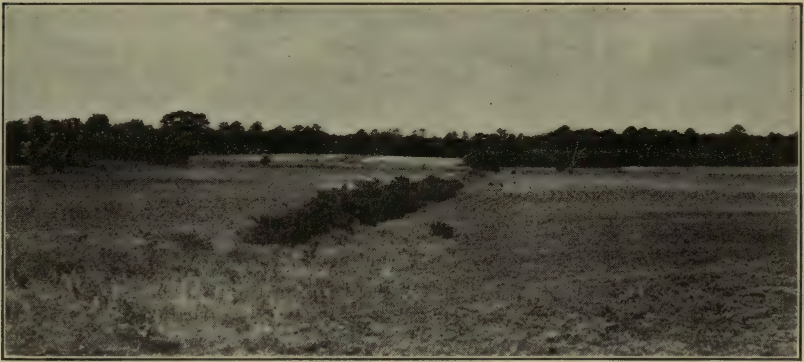
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FIGURE 3.—Good farm cover for bobwhites, showing planted hedgerow, diversified woods with extensive borders, standing grain (background), and a good proportion of uncultivated land.

TABLE 1.—*Game chart for the average farm*

Species and region	Nesting season	Eggs or young	Environment
Bobwhite quail—east of the Rockies.	May to July	9 to 16	Moderate cultivation, with plenty of woods, thickets, vines, and fruits.
Ring-necked pheasant—Northern States.	April to July	9 to 15	Moderate to intensive cultivation; best with nearby marshes or swamps. Under ideal conditions these birds can exist on crop lands alone.
Prairie chicken—Corn Belt and the Southwest.	May to July	10 to 15	Very moderate cultivation. Large areas of marsh or grass, and farm of more than average size required. These birds cannot thrive where farming is intensive.
Ruffed grouse—Northern States and Alleghenies.	April to May	9 to 17	Ungrazed mixed woods required; reduction of woods under 15 to 40 acres drives these birds out.
Hungarian partridge—northern Corn Belt and the Northwest.	May to July	8 to 20	Cultivation required, but thickets and other cover are used.
Cottontail rabbit—entire United States.	March to August	[1] 4 to 8	All habitats, but moderate cultivation and plenty of low coverts preferred.
Squirrels—Northern States	May to June	4 to 6	Woods or forest.

[1] Probably 2 litters of this size.

COVER TYPES

Farm game cover may be classified as concealing (or confusion), shelter, nesting, and emergency cover.

CONCEALING COVER

Concealing (or confusion) cover is anything in the environment that effectually hides the game concerned. Such cover is essential to the game's sense of security, but what is sufficient for one species may not be adequate for another. All such cover should be thick enough to afford some degree of concealment, though it should not be so thick as to keep game from maneuvering easily. Where possible, concealing cover should be extensive enough to introduce the element of confusion. Who has not seen a hunted animal make its get-away in only moderately good concealing cover that was sufficiently extensive, however, to cause the pursuer to be uncertain in regard to which of several possible courses the intended prey had taken? Small patches of concealing cover are useful, though of less value.

SHELTER COVER

Shelter cover is that affording protection from the weather. Wild game in healthy condition and with plenty of food can withstand the elements well. Ruffed grouse dive under snow and make use of the snow itself for protection. Some other birds—the Hungarian partridge and the quail, for instance—make use of snow, too, and sometimes even enter deserted barns or similar artificial shelters during severe weather. Many wild birds and mammals resort to wooded swamps during blizzards. Windbreaks of various kinds, especially growths of evergreens, are of service to wild life, particularly where protection from wind is combined with exposure to sunshine, as on the south side of a wood lot.

NESTING COVER

Nesting cover varies greatly. Ruffed grouse require woodland. Hungarian partridges nest in fields of alfalfa, oats, wheat, and similar crops. Quail more or less favor roadsides, the margins of rights-of-way, fence rows, grassy fields, and a variety of similar nesting situations.

The cooperative quail investigation, carried on in southern Georgia and northern Florida, disclosed that of 602 nests of the bobwhite studied, more than half were in broomsedge fields (which correspond in a general way to the grasslands of the Northern States), 16 percent were in woodland, 14 percent in fallow fields, and only 4 percent in cultivated fields. It is probable that in the Northern States, with more intensive farming, there is a higher percentage of nests in cultivated fields. As a rule, such nests are made close to permanent cover.

In wild-life management, nesting cover must be carefully provided for. It is useless to attempt to change the habits of wild creatures; the environment must be adjusted to their requirements. Ruffed grouse, for example, will not move into fields to nest when their woodland nesting cover has been grazed out; they will either move away to some favorable woods or be eliminated by natural agencies. Thus, it is essential to know what the general requirements of game are before an attempt is made to manage specific species, but there are a number of broad principles that are applicable to the development of cover on practically all game-management areas.

EMERGENCY COVER

Emergency cover as here used means cover to which wild creatures can flee when pursued; it may be entirely different from other kinds. Rabbits chased by dogs dash into brush heaps or hollow logs; quail pursued by Cooper's hawks have been observed to take refuge in rolls of old fence wire; many species resort to brier patches, tangles of honeysuckle, greenbrier (also called cat brier), rose thickets, Osage-orange hedges, and other places that are similarly effective as barriers to their larger enemies. Emergency cover is extremely important, and where it is available in close proximity to food supplies, game will persist even in the presence of numerous natural enemies. Great care should be used to develop adequate emergency cover on farms where game is to be encouraged. On every such farm some cover should be thorny enough or dense enough to afford game added refuge from predators.

In table 2 is shown the value to wild life of several kinds of cover. The vegetation listed is meant to include not only the particular cover-forming species named, but also the general environmental association in which they ordinarily occur. This table is most applicable to the Northern and Eastern States.

TABLE 2.—*An appraisal of cover useful to wild life*

[Cover favorable to the increase of wild life is indicated by X; very favorable by XX; that also having both cover and food value [1] by F or FF; and that generally of low value by a blank (leaders). The appraisal is in each case an approximation, its application to particular localities being subject to wide variation.]

Cover	Value for—														Value against predators
	Bobwhite quail	Ring-necked pheasant	Prairie chicken	Ruffed grouse	Hungarian partridge	Cottontail rabbit	Snowshoe rabbit	Fur animals	Squirrels	Woodcock	Jacksnipe	Waterfowl	Tree birds	Field birds	
Ungrazed wood lots:															
Second-growth hardwood	FF	FF	-----	FF	-----	FF	FF	FF	FF	X	-----	-----	FF	X	XX
Mature hardwood [2]	X	X	-----	F	X	X	-----	X	F	XX	-----	-----	X	X	X
Swamp hardwood	F	F	-----	FF	-----	FF	F	FF	F	XX	-----	-----	FF	-----	XX
Hardwood and conifers	FF	FF	-----	FF	-----	FF	FF	FF	FF	X	-----	-----	FF	X	XX
Tamarack and spruce	-----	F	-----	FF	-----	FF	FF	XX	F	XX	X	-----	FF	X	XX
Young pine and spruce	XX	XX	-----	FF	FF	FF	FF	XX	FF	X	-----	-----	FF	-----	XX
Mature pine and spruce [2]	F	X	F	F	-----	X	X	X	FF	XX	-----	-----	FF	-----	X
Aspen	-----	-----	-----	FF	-----	F	FF	X	-----	X	-----	-----	X	-----	X
Boxelder and cottonwood	X	X	-----	X	-----	X	-----	X	-----	-----	-----	-----	X	X	X
Windbreaks, hedges, and fence rows:															
Osage-orange (untrimmed)	XX	XX	-----	-----	XX	XX	-----	X	-----	-----	-----	-----	XX	XX	XX
Prickly-ash	XX	X	-----	F	XX	XX	-----	X	X	-----	-----	-----	X	FF	XX
Wild plum, hawthorn	FF	FF	FF	FF	X	X	X	F	F	-----	-----	-----	FF	FF	XX
Cherries, mountain-ash	FF	FF	FF	FF	X	X	X	F	F	-----	-----	-----	FF	FF	XX
Young pine and spruce	XX	XX	X	-----	XX	FF	-----	XX	X	-----	-----	-----	XX	XX	XX
Mature pine and spruce	F	X	-----	-----	-----	X	-----	X	FF	-----	-----	-----	FF	FF	X
Arborvitae (untrimmed)	X	X	-----	X	X	X	FF	X	X	X	-----	-----	FF	FF	XX
Redcedar	F	F	-----	F	X	X	-----	X	F	-----	-----	-----	FF	FF	XX
Dogwood, serviceberry	FF	FF	F	F	F	X	F	F	-----	-----	-----	-----	FF	FF	XX
Sumac	F	FF	FF	FF	FF	FF	F	FF	X	-----	-----	-----	FF	FF	X
Briers and berries	FF	FF	FF	FF	FF	FF	FF	XX	F	-----	-----	-----	FF	FF	XX
Grassy fence rows	FF	FF	X	-----	FF	F	-----	FF	-----	-----	-----	-----	X	FF	X
Vines, with other cover:															
Wild grapes	FF	F	F	FF	F	FF	X	F	F	-----	-----	-----	FF	FF	XX
Bittersweet	FF	F	F	FF	X	FF	F	X	X	-----	-----	-----	FF	FF	XX
Virginia creeper	FF	F	F	FF	F	XX	X	X	X	-----	-----	-----	FF	FF	XX
Japanese honeysuckle	XX	X	-----	XX	-----	XX	-----	X	X	-----	-----	-----	FF	FF	XX
Greenbrier	FF	F	F	FF	X	FF	XX	X	X	-----	-----	-----	FF	FF	XX
Cultivated crops, etc.: [3]															
Standing corn	FF	FF	FF	-----	FF	FF	-----	F	F	-----	-----	F	F	F	X
Shocked corn	FF	FF	FF	-----	FF	FF	-----	F	F	-----	-----	-----	F	F	FF
Standing small grain	FF	FF	FF	-----	FF	FF	F	XX	F	-----	-----	F	FF	FF	X
Small-grain stubble	FF	FF	FF	-----	FF	F	-----	X	-----	-----	-----	-----	F	FF	X
Ragweed, amaranth, etc	FF	FF	FF	-----	FF	F	-----	X	-----	-----	-----	-----	FF	FF	X
Fallow fields	FF	FF	F	-----	FF	F	-----	XX	X	-----	-----	-----	F	FF	XX
Truck gardens	FF	FF	X	-----	FF	FF	-----	-----	-----	-----	-----	-----	FF	FF	X
Orchards	FF	FF	F	F	X	FF	-----	X	X	-----	-----	-----	FF	FF	X
Wooded lawns	FF	F	-----	-----	-----	F	-----	-----	FF	-----	-----	-----	FF	X	-----
Vineyards	FF	FF	FF	-----	FF	FF	-----	FF	X	-----	-----	-----	FF	FF	X
Berry patches	FF	FF	FF	-----	FF	FF	-----	FF	X	-----	-----	-----	FF	FF	X
Red and white clover, alfalfa	FF	FF	FF	-----	FF	FF	F	X	-----	-----	-----	-----	X	FF	X
Sweetclover	X	FF	X	-----	FF	FF	-----	XX	-----	-----	-----	-----	FF	FF	XX

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[1] The value of coverts in providing foods taken by fur animals is usually indirect: for example, mice, preyed on by fur bearers, are found in grassy marshes, though the vegetation itself is not eaten by the fur animals.

[2] Not in dense stands.

[3] Most of these have only seasonal value, or only portions near coverts are usable.

TABLE 2.—*An appraisal of cover useful to wild life*—Continued

Cover	Value for—														Value against predators
	Bobwhite quail	Ring-necked pheasant	Prairie chicken	Ruffed grouse	Hungarian partridge	Cottontail rabbit	Snowshoe rabbit	Fur animals	Squirrels	Woodcock	Jacksnipe	Waterfowl	Tree birds	Field birds	
Ungrazed marshes:															
Cattail	-----	XX	FF	-----	-----	X	-----	FF	-----	X	X	X	X	X	X
Sedges	F	FF	FF	X	X	F	X	XX	-----	X	X	F	XX	FF	X
Potholes	F	FF	FF	X	X	F	X	XX	-----	X	X	F	XX	FF	X
Grassy marshes	F	XX	FF	-----	-----	F	-----	XX	-----	X	XX	F	X	X	X
Ponds and lakes:															
Shallow, well vegetated	-----	-----	-----	-----	-----	-----	-----	-----	-----	F	FF	F	X	X	-----
Deep, little vegetation	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Streams	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Unclassified cover: [4]															
Brush heaps	XX	XX	X	X	X	FF	X	X	X	-----	-----	-----	X	X	XX
Large thorny roses	XX	FF	FF	FF	X	FF	X	XX	X	-----	-----	-----	X	X	XX
Untrimmed tree tops	XX	X	XX	XX	X	FF	FF	X	X	-----	-----	-----	X	X	X
Woodpiles	-----	-----	-----	-----	-----	XX	-----	XX	X	-----	-----	-----	-----	-----	XX
Hollow logs	-----	-----	-----	-----	-----	XX	-----	XX	X	-----	-----	-----	-----	-----	XX
Hollow trees	-----	-----	-----	-----	-----	XX	-----	XX	X	-----	-----	-----	XX	-----	XX
Stone walls	X	X	-----	-----	X	XX	X	XX	X	-----	-----	-----	-----	X	XX
Straw stacks	F	F	F	-----	F	FF	-----	X	X	-----	-----	-----	F	F	X
Wire entanglements	XX	X	X	XX	XX	XX	X	X	X	-----	-----	-----	X	X	XX
Rail fences	XX	X	X	X	XX	XX	X	XX	X	-----	-----	-----	X	X	XX
Culverts and tiles	-----	-----	-----	-----	-----	XX	-----	XX	X	-----	-----	-----	-----	-----	XX
Old buildings	X	X	-----	-----	X	X	-----	X	X	-----	-----	-----	-----	-----	X

[4] In connection with other cover.

COVER MANAGEMENT

TOO MUCH COVER POSSIBLE

The value of plants for cover depends a great deal on local circumstances, rate of growth, and other factors, and there is such a thing as having too much cover as well as the more common fault of not having enough. In southern quail territory an interesting example of the value of cover at one stage of growth and its detrimental effect at a later stage is found in the case of the so-called "broomsedge." This grass (*Andropogon*) is sufficiently open for a couple of years to be inviting to quail; but its continued growth, combined with the accumulation of the debris from other years, eventually results in choking out all food plants, and such overdensity makes the sedge a habitat shunned by quail but attractive to many cotton rats (*Sigmodon*) and other undesirable animals. Such accumulations, furthermore, are serious fire hazards. Burning was found to be the best way of disposing of the plant; the best time to do this is during cool nights late in the winter. With plenty of men available to supervise such burning, this method is satisfactory. It has come to be an extensive practice on southern quail preserves, and not only improves conditions for game but gives better protection to timber.

A too-luxuriant growth of deciduous trees and shrubs in southern pinelands held primarily for quail shooting was also encountered in the cooperative quail investigation. In fact, any growth that shuts off so much light from the ground that the favorite food plants will not grow is undesirable.

In the North, in those rare instances in which the burning of cover is desirable (as, in burning off a dry marsh area that is almost certain to be flooded later on, thus preventing the nesting of game birds in a hazardous situation), it is frequently possible to burn safely just after the disappearance of snow. Where there is legitimate reason, marshes may generally be burned while still frozen.

DIVERSITY OF COVER

Uniform cover conditions tend to limit the number of species, or the number of individuals, or both, whereas diversification ordinarily increases the number of both species and individuals. This is merely another way of saying that a farm with wood lot, shrubbery, brushy gullies, hedgerows, pond, creek, wooded swamp, grassy swale, standing corn, standing sweetclover, and weeds, and with ordinary crop stubble, can harbor much more wild life than can a farm that has only stubble, only standing corn, or any other uniform environment.

DISTRIBUTION OF COVER

In addition to being diversified, cover should be distributed—but not too widely. If a quarter-section farm, for instance, has an excellent wood lot suitable for quail on the extreme northwestern corner, and a small field of standing corn on the extreme southeastern corner, with no cover between, neither cover nor food is of maximum availability. It would be better to have the corn and the wood lot close together, but if some sort of cover linking the two is provided, even though they are not close, their availability to wild life will be increased. It is, then, desirable to have coverts connected, or not too widely spaced.

The distribution of cover is particularly important as regards its location in relation to food. Cover without food is worthless. Dense shelter, food-producing range, nesting cover, and other necessities must be provided, and the more unit areas furnishing all these requirements throughout the year, the more coveys of quail there will be. This principle applies to all wild life.

There are numerous other considerations in distributing cover. Strip cover, for example—coverts arranged in long, narrow areas—is most valuable in summer; if dense enough, it is valuable at all seasons. Many other such details will be learned through experience. Well-arranged coverts also increase the recreational value of hunting.

DEVELOPMENT OF COVER

With these cover requirements in mind, and having considered the general types of cover—concealing or confusion, shelter, nesting, and emergency—the kinds of coverts on the typical American farm ordinarily available to song, insectivorous, and game birds, and to fur animals may now be dealt with.

FARM WOOD LOTS

One common cover area is the wood lot. The 167,000,000 acres of farm wood lots in the United States have been recognized as valuable in producing fuel, lumber, and posts; in conserving moisture; in checking erosion; as windbreaks and snow fences; in the production of a number of products, such as maple sugar, Christmas trees, and wild nuts and berries; and in promoting general recreation. But heretofore, apparently, little consideration has been given to wood lots as game-production areas, though they contain most types of game coverts. The potential game production of farm wood lots, which average 24 acres to a farm—17 percent of our total farm area—is too large to be lightly dismissed; yet their potential production has scarcely been imagined, much less achieved.

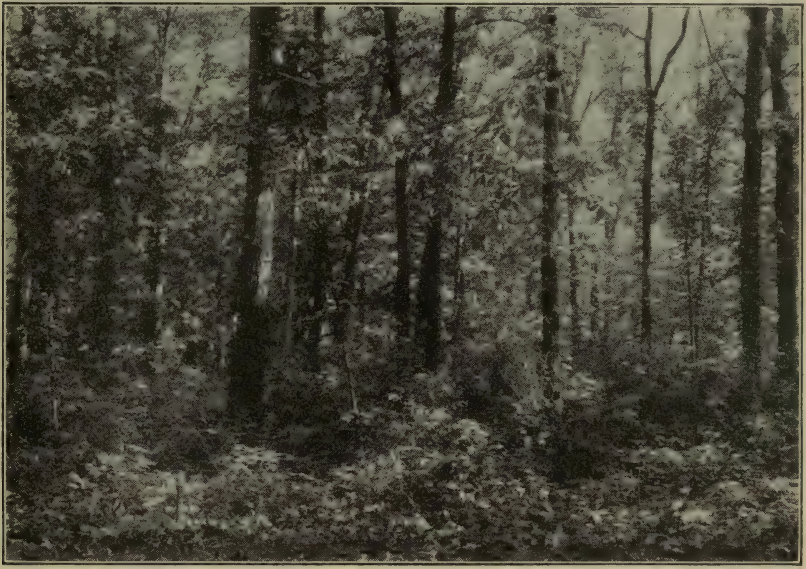

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FIGURE 4.—An ideal farm wood lot (ungrazed), attractive to wild life and productive of useful forest crops. Compare with figure 5.

For one economic reason or another, as just outlined, or to make the farm a more attractive, enjoyable spot on which to live, it is profitable to extend wood lots to practically all waste places that are suited to forest growth and are submarginal for agriculture. In fact, it can be shown readily that well-managed wood lots (fig. 4) and their associated products are among the most valuable of farm crops and may contribute more to farm income than similar acreages of wheat, corn, or pasture. Information on wood lots is contained in Farmers' Bulletins 1117, Forestry and Farm Income, and 1177, Care and Improvement of the Farm Woods. Rocky fields, hillsides, gullies, and odd corners set out to trees should at least pay the taxes, and with the same kind of care given crops, they should yield a profit.

In a great many cases thoughtfulness of wild life will make it possible to handle the wood lot so as to encourage animals and birds and yet not interfere with the work. If the farmer cutting his winter wood, for example, remembers that the tops of maple, ironwood, and birch are delicacies for rabbits, he may postpone the burning of the brush heaps until early spring, well before the dry season. And if he does this, he will find trails worn down from heap to heap by the rabbits that are attracted to them. Later, when burning the brush, if he leaves a few heaps, in places where they will not constitute a fire hazard, the grass will grow up through them and they will form ideal resorts for rabbits and songbirds.

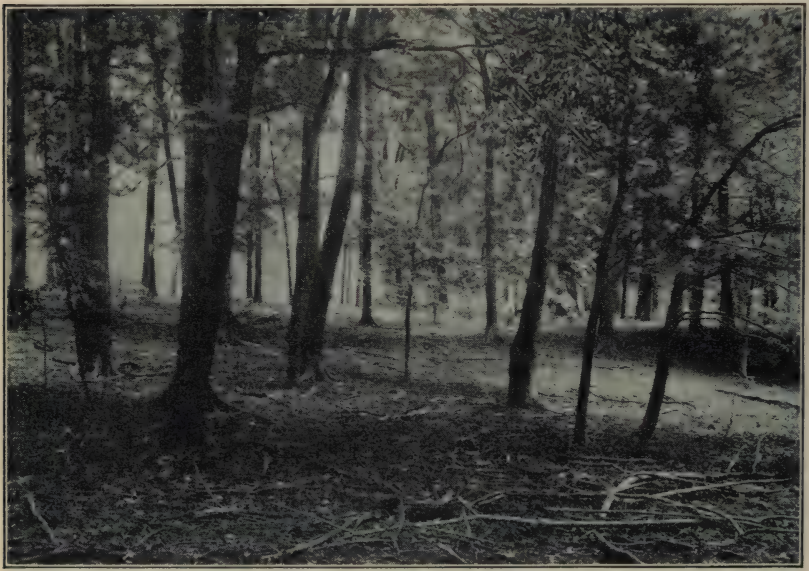
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FIGURE 5.—The result of heavy grazing of the farm wood lot, unproductive even of forage; devoid of shrub-loving wild creatures; no reproduction of young trees; mature trees endangered by exposed and trampled roots. Although this illustrates the extreme condition, even moderate grazing is destructive.

And, if he piles his firewood on poles or logs, the woodpile will form an attractive shelter for rabbits, especially in fall and summer. There are, indeed, many ways in which wood lots can be made more productive of wild life. Some of these methods are considered in the following pages.

CONTROLLING GRAZING

The grazing of small farm wood lots by cattle, sheep, or hogs is ordinarily disastrous (fig. 5) to forestry or wood-lot perpetuation, because of the elimination of young growth, and is, at best, of questionable value from an agricultural viewpoint, because of the low forage value of wood lots. Light pasturing may not be especially destructive, but the tendency is always toward overgrazing. Furnishing livestock with shade, is, of course, a good use of wood lots, but shade can be provided without permitting cattle to eat all the young growth, compact the soil, and injure the older trees. (See Leaflet 86, Protect Hardwood Stands from Grazing.)

Grazing wood lots kills many shrubs, trees, sedges, and berries that are important producers of the food so essential to wild life. The elimination of cover by grazing is so pronounced and its effect so serious that some kinds of game disappear within a few months after invasion of livestock. Almost all coverts are injured, and many are destroyed, by grazing.

Consequently, where game or other terrestrial wild life is a consideration, wood-lot grazing by livestock should either be entirely eliminated or confined to one small portion of the woods by means of a stock-proof fence. If this cannot be done, reasonably large areas within the woods should be fenced against livestock and allowed to grow up for the benefit of game. The planting of natural barriers, such as thorny trees and shrubs, would partially protect the wood lot against cattle.

PREVENTING FIRES

The importance of fire control in farm wood lots is obvious. Fire kills valuable young trees, destroys important foods of wild creatures, reduces cover, and often makes woodland uninhabitable to its former denizens. Fire at any time during the season for eggs and young is of the nature of a catastrophe in the bird and animal world, to be compared with earthquakes and hurricanes in relation to human beings. It should be a principle rigidly adhered to that fires be kept out of wood lots, marshes, and other game coverts, except in rare cases when controlled fires are used for specific purposes, under very careful supervision. In connection with wood-lot management, fire is sometimes of use. Legitimate uses include making small clearings, which may grow up to wild berries, or keeping combustible material within controllable proportions rather than allowing it to accumulate to the extent that it becomes a serious fire hazard. It cannot be too much emphasized, however, that uncontrolled fires are tremendously destructive. Under all ordinary circumstances, a running fire on a farm is a liability, even where set with good intentions. Fire has no place on game-management areas except as a tool in reducing vegetation, and then only when adequate precautions are taken.

DIVERSIFYING THE WOOD LOT

The principle of diversity is applicable within the wood lot as well as to cover in general. The greater the variety of trees, shrubs, and vines, the greater is the value of the wood lot as a home for wild life.

Grapevines, for instance, may well be encouraged in portions of the wood lot where they will not damage valuable trees. Where a vine is growing over a tree of little value, the tree may be cut down and the vine allowed to ramble over the fallen top, thus forming an ideal resort for quail and pheasants. Some such places should be in the borders and some in the interior of the wood lot. Virginia creeper and bittersweet should also be encouraged in the wood lot and on fences. If grown in quantities, bittersweet has commercial possibilities for decorative purposes. All these plants lend themselves to culture and transplanting, and may be increased as desired.

There should be a large variety of trees, and the trees themselves should be of different ages and sizes. A woods with uniformly large, mature trees could be much improved for most kinds of game by the clean-cutting of a few small areas, which would then grow up to brushy vegetation. Furthermore, uniformity in stands of tree species encourages insect damage, and diversified woodland is thus consistent with good forestry. Even hollow trees and stubs hollowed out by woodpeckers are valuable, and plenty of them should be left standing—or the hollow logs left lying on the ground. Squirrels, raccoons, chickadees, small owls, woodpeckers, and many other birds use the stubs, and rabbits and fur animals use the hollow logs. A few stubs are a good thing in any wood lot.

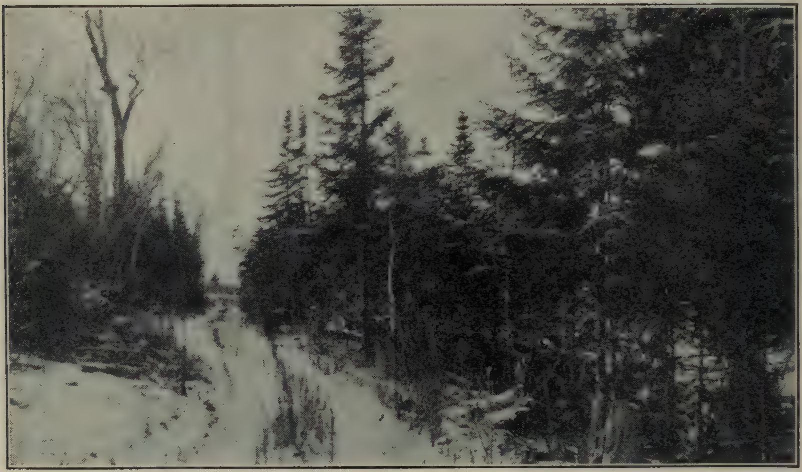
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FIGURE 6.—Good ruffed-grouse, snowshoe-rabbit, deer, and red-squirrel country. Conifers offer shelter and concealment, and stumps and brush afford emergency cover. This growth is young enough to have considerable food value for rabbits, deer, and grouse.

MAKING OPENINGS IN LARGE WOOD LOTS

Openings, clearings, paths, woods borders, and roads, because of the increased sunlight that they receive, are productive of shrubs, vines, grasses, and other valuable food-producing plants, and thus are of value to wild life (fig. 6). Anything that will increase these natural wild-life attractants is a practical game-management measure. There should thus be plenty of paths, openings, and trails throughout the wood lot—places where the sun can reach the earth, even in the thick woods. The value of such openings is shown by the fact that of the hundreds of bobwhite nests studied in the cooperative quail investigation in Georgia and Florida, 74 percent were within 50 feet of paths, roads, or similar open spaces in a denser environment.

On the other hand, if picnic grounds are to be made, the farmer should see that brush and other vegetation are cut out of a limited area only—just enough to afford ventilation and a view. The whole woods should not be denuded for this purpose.

When wood lots are being planned for wild life, it is well to bear in mind the advantages both of blocking woods in separate sizable areas (fig. 7) and of greatly extending borderlands. Blocking affords more sheltered sides or woodland lees, hence better protection from the elements, and by furnishing numerous coverts it gives a greater opportunity for escape from enemies. On the other hand, borders of woods hold most of the fruits, berries, and sunlight-loving plants that are attractive to game, and such borders can be extended profitably. The maximum shrub, vine, and berry growth is obtained by judicious use of the blocking system, with many indentations, arms, and openings.

It is well also to bear in mind the fondness of most wild birds and mammals for dusting. Ashes, dry earth, dust, the crumbling wood of rotten logs, even ant hills, are used for this purpose. Deliberate effort may well be given to the provision of little sunny openings in deep woods, well supplied with dusting material, and to the provision of adequate dusting facilities about the borders. Dusting seems to be of use in ridding birds and mammals of external parasites, and accordingly it may be desirable at times to sprinkle some mild insecticide in the dust baths that are being used. Supplying many dusting places has the further advantage of preventing undue concentrations of game and the consequent greater risk of disease and parasite transmission. This matter should receive increased attention as the wild-life population rises on the managed area and as the possibility of transmission thus increases.

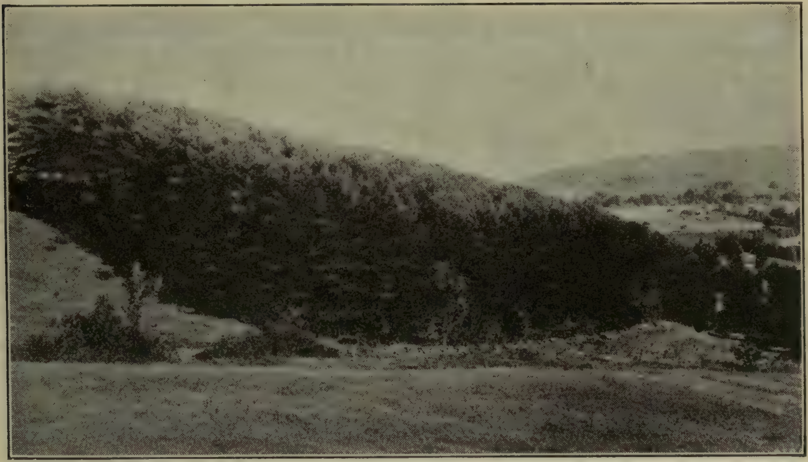

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FIGURE 7.—This hillside, formerly unproductive and worn out, was planted to white pine in 1873. It sold for $350 in 1901 and for $1,000 in 1912; and thereafter its value continued to increase. An excellent type of winter emergency cover for quail and rabbits, but too small for ruffed grouse. The food supply could be increased by planting the stone-wall area in the right foreground to berries, grapes, or bittersweet, and having a small patch of standing corn. The borders could also be made more attractive for songbirds and fur animals.

PLANTING EVERGREENS

Many wood lots are deficient in winter concealing cover and in windbreaks. Spruces, firs, and pines offer an excellent means of increasing such cover, especially where used in conjunction with thorny growths and low evergreens. such as juniper. Evergreens with Osage-orange, wild plum, prickly-ash, or the larger thorny roses also make excellent cover. Coniferous trees are valuable for a great variety of songbirds as well as for game.

If the farm lacks evergreens, it is well to plant some in the wood lot, in spots where shade is not too dense. It would also be well to dedicate an entire half acre or more to Christmas trees. If spruces of excellent quality are planted, it will be possible to harvest a portion each season after the fourth or fifth year and still leave enough to produce timber or fuel. For the maximum value to wild life, the Christmas-tree tract should be near the wood lot. Further information on this subject is given in Farmers' Bulletin 1453, Growing and Planting Coniferous Trees on the Farm.

PROVIDING WATER

Many birds obtain water from dew or in their food and are more or less independent of running or standing water, even though they make use of it when available. In general, tree birds are dependent to a great extent on free-water supplies. Some birds are definitely so dependent—the mourning dove, for instance, at least during the nesting season, as water is necessary for the yield of " pigeon milk ", the semiliquid, partially digested food that is regurgitated into the gullets of the young birds. Doves fly long distances for water and then return, but other species may forsake unwatered territory. Aside from the purely biologic necessity of drinking, water is resorted to by the birds for bathing and cooling purposes and is thus enjoyed much in the same way as it is by human beings. Most wild creatures are about as responsive to luxuries as people are and for their homes prefer places where these are provided.

The wood lot should, therefore, if possible, have water available at all times. Care should be taken, however, that the water supply does not constitute a trap where wild creatures can easily be picked up by their enemies. If the wood lot is not near a stream or pond it may be possible to introduce a dependable water supply.

WINDBREAKS AND THICKETS

The use of windbreaks and hedgerows varies with the locality. Some sections of the country, like the famed English countryside, owe their beauty and general attractiveness largely to growths of vegetation between fields, so useful in breaking the monotony of crop lands. Others appear drab through absence of between-fields greenery. Fence-row cover, wherever found, ranks extremely high in its wild life and game utility, and while windbreaks occupy acreage and reduce crop yield on adjacent strips, they also have advantages to farms, especially in sheltering buildings and orchards, in addition to their ornamental appearance and utility to wild life. The desirability of increasing hedgerow growth depends much on the type of cover afforded, as some kinds have little and others much value from the agricultural standpoint. A food-supplying function may also easily be provided for, as Russian-olive, buffaloberry, and hackberry, all good bird foods, are highly recommended for windbreaks. Almost all types—whether shrubby bushes, berry plants, actual woods, weedy fence rows, or grassy tangles covered by grapevines and Virginia creeper—are of value to wild life.

The additional advantages of these are various. The wild grape, to mention one, will grow over dump grounds, stone heaps, stone walls, in gullies, and on steep hillsides, as well as in the wood lot, and once well established is an effective erosion-checking plant. Windbreaks and hedgerows can also be used to hide unsightly spots, such as dumping grounds or old machinery.

Windbreaks (fig. 8) in some instances have also been known to prevent grain from lodging or blowing over in the wind, and in sections where such damage is common they will thus prove to be of some value as wind insurance for crops. (See Farmers' Bulletin 1405, the Windbreak as a Farm Asset.)

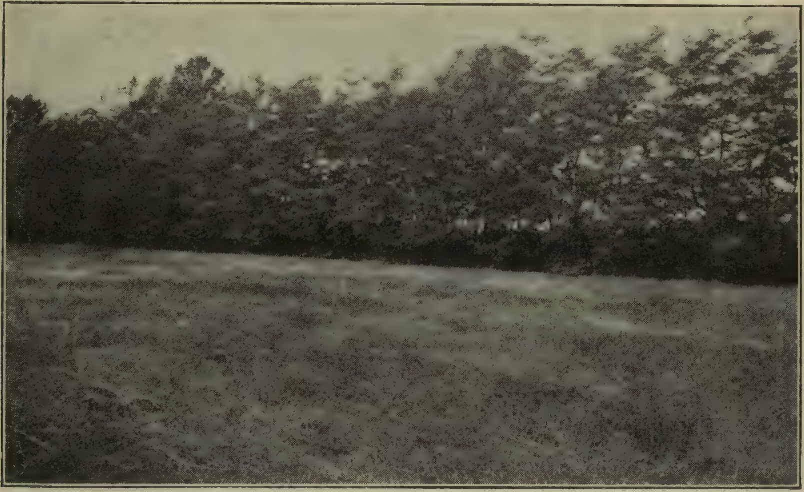
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FIGURE 8.—Honeylocust windbreak in Nebraska. Good summer cover for bobwhites, Hungarian partridges, songbirds, rabbits, and fur animals. Winter value could be improved by underplanting with low evergreens and adding vine and shrub cover. A strip of unharvested hay and one of unharvested corn would make this covert of much greater utility, especially for ring-necked pheasants.

Hedges and windbreaks when used should be pruned for dense, bushy growth. The hedgerow that has grown up, leaving the bottom open, is ineffective as a windbreak and of little use to ground game. Vines, shrubs, and berries should also be encouraged along fence rows and hedges, and for nest cover some grass should be left adjacent to hedges. Osage-orange, honeylocust, catalpa, plum, cherry, evergreens, prickly-ash, boxelder, cottonwood, or other species should be planted in accordance with recommendations of the State agricultural experiment station. Hollow logs or tiles placed at intervals in the windbreaks and hedges will be used by rabbits and fur animals. To give wild life the best advantages of continuous cover, hedges and windbreaks should be connected with woods and marshlands.

SNOW FENCES

In recent years, thousands of miles of snow fences have been built in the Northern States for road protection. The same purpose can be served by planting windbreaks at the same distance from the road. In fact, a leading agricultural magazine has for years been advocating this method of handling the problem. Civic organizations are interested in the road-beautification aspect of such plantings.

WINDBREAKS FOR TIMBER AND POSTS

It has already been mentioned that the agricultural utility of a hedgerow or windbreak depends much on how it is managed and to what it is planted. It is perfectly feasible to plant hedgerows to trees suitable for post or timber production and also valuable to game. Posts are used on all farms, and they cost a considerable amount if purchased. Lumber and firewood, also, can be harvested in moderate quantities from hedgerows. One of the best timber-producing hedgerow trees is black walnut, while those ordinarily used for posts and fuel are catalpa, poplar, Osage-orange, and a variety of the more common ornamental trees.

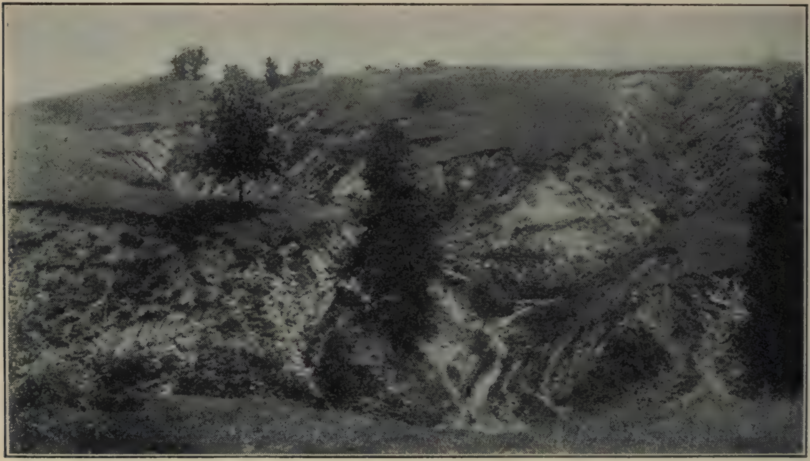
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Figure 9.—Eroding farm land in Illinois. By means of revegetation, this waste area could be made productive of timber, fur, and game.

VALUE OF THICKETS IN CHECKING EROSION

One of the significant results of too intensive cultivation is the increased rapidity with which soil is washed away by heavy rains (fig. 9). Even in the course of ordinary rains the gullying of cultivated fields is enormous, particularly where the land is rolling.

It has been said by good authorities that the abandonment of many farms because of low fertility is due more to the washing away of the rich topsoil than to exhaustion by crops.

According to the Yearbook of Agriculture, 1928, p. 575—

> Most of the worn-out farms scattered throughout the United States were not worn out by producing crops but because the owners did not take steps to prevent the washing away of the fertile topsoil. Many productive farms will join the worn-out class in a few years unless soil erosion is prevented.

Well-placed game coverts may be used for this purpose. In fact, among the most practical means of handling gullies and washes already existing upon farms is the encouragement or planting of vegetation to catch and hold soil. The same methods apply to drainage-ditch banks, exposed embankments, and road cuts, from which debris commonly washes down upon highways in wet weather. Even the creek and river banks subject to undermining by currents in flood times may often be held permanently by the regular planting of willows. These trees may be planted effectively if long willow poles or tree trunks, 2 inches or more in diameter, are used, half buried in trenches at right angles to the stream, the butts of the poles within reach of ample moisture. A systematic entrenchment of such poles, with due regard to moisture conditions, will frequently result in an astonishing growth of verdant cover and the eventual development of extensive soil-binding root systems, which finally defy the swiftest currents. Along smaller streams it is feasible to use branches and willow shoots, which, fortunately, take root rapidly where moisture conditions are favorable.

Willow is perhaps the most widely available and rapidly growing soil binder for lowlands; furthermore, it affords cover used by many small birds and, when in large clumps, by game birds. Willows overhanging creeks and streams also multiply the insect food available to fishes and increase shade, consequently keeping the water temperature more habitable for some of the colder-water fishes.

The black locust is another tree of great use in checking erosion. It also is a rapid grower, but is less dependent on moisture than are willows. It makes excellent posts and furnishes cover to a variety of birds.

Other useful agents in erosion control are sod-forming perennial grasses, briers, vines of several sorts, some of the more thrifty shrubs, and various trees, choice of which depends on the soil, moisture, and grade conditions, as well as on the objective. County agricultural agents and State agricultural colleges are generally able to furnish detailed information on the most effective local methods in various parts of the country.

Since few farmers would seriously object to a small expenditure that would at one and the same time provide dependable erosion insurance and an attraction to wild life, the control of farm-land erosion by the simple methods just outlined should come into more favor; but there seems to be wide-spread indifference to the dangers attendant upon erosion and ignorance of revegetative methods for use in its control. Information on remedial measures is available in Farmers' Bulletin 1234, Gullies and How to Reclaim Them.

MISCELLANEOUS ADVANTAGES OF BETWEEN-FIELDS COVER

Some advantages of fence-row cover are less susceptible of measurement. One of these is the role of windbreaks in protecting orchards from serious frost, discussed in Farmers' Bulletin 1405, previously mentioned. Frost does not generally hurt orchard trees unless it occurs after the trees have begun spring activity. Too early budding or flowering invites damage, and windbreaks can be utilized in screening orchards to such an extent that late budding and flowering are encouraged, thus putting these activities of the trees past the usual frost period. In summer, however, the temperature is raised in well-protected fields, owing to lack of evaporation and its consequent cooling effect. This condition can be used to advantage in maturing certain crops that need the benefit of every possible additional degree of temperature.

So-called "waste lands", as the term is applied to fence-row strips and odd uncultivated nooks about farms, may, as has been shown, be made productive lands, rich in fur and game, beneficial to growing crops, and themselves capable of producing crops of game and fur. "Waste lands" often can produce more income to the acre than areas cleared a few years ago and now devoted to low-priced standard crops.

Clean cultivation of actually tilled land is, of course, an essential element of good farming. Leaving, where possible, woods, hedgerows, marshes, and other between-fields cover is also good farming and a logical corollary of clean cultivation, as farms without some interspersed ground cover are not only devoid of beneficial wild life but also are more subject to erosion, lodging of crops, and the increase of destructive insects.

The following list summarizes the more common beneficial results to general agriculture from the extension and encouragement of between-fields coverts:

Prevention of erosion.
Conservation of moisture by snow storage.
Protection of buildings from blizzards.
Protection of roads by living windbreak snow fences.
Reduction of wind-blown losses of soil.
Protection of fields from stock.
Increase of those beneficial species that prey upon insects destructive to crops.
Encouragement of birds that eat harmful insects and destructive rodents.
Protection of orchards from too-early spring growth and consequent later freezing.
Production of farm timber and posts, of berry crops, and of sumac for tannin extract.

Although numerous indirect economic benefits accruing from the establishment and preservation of between-fields coverts have thus been pointed out, this discussion should not lead to the conclusion that such coverts are intrinsically so valuable, quite aside from their effect in increasing wild life, that the farmer who has established them merits no special consideration by hunters and by those who make regulations for hunting. Windbreaks and tall hedgerows occupy acreage that might otherwise be planted, reduce crops on adjacent strips, and harbor injurious as well as beneficial forms of plant and animal life. These adverse factors should be borne in mind. A definite effort to give landowners who develop and preserve their coverts an increasingly large share of responsibility and ownership in the game thus encouraged is necessary to stimulate further covert development and assist in the legitimate use of a heretofore-neglected type of agricultural crop.

ORCHARDS

Old-time orchards were ideal places for birds and other wild life. The tree cavities furnished nesting sites for some, clumps of apple suckers and bushy fence rows favored others, and weedy growth provided cover for numerous forms of wild life. With the cover came natural supplies of food in plenty.

Tidying up the orchard decreases its value to wild life, and modern clean culture and top-notch care almost exclude the wild birds and mammals. Bird houses can be put up on poles, however, and some forms of winter feeding adopted. A New York pear grower found that pieces of suet fastened in the trees attracted nuthatches in such numbers that they consumed practically all the hibernating pear psyllas—serious pests of the orchard. Chickadees, titmice, small woodpeckers, and other winter birds that can be similarly provided for, search diligently for insect eggs, scale insects, and other orchard-enemies. Encouragement of such allies certainly will repay any orchard owner.

The apple tree that holds its apples in fall and winter is attractive to many birds. Robins that remain in the North, sometimes live partly upon hanging apples, even in winter. Cedar waxwings, grosbeaks, starlings, and ruffed grouse also feed on them. Russets have especially persistent fruit, and one or two of these trees in the orchard will be well worth while.

An old apple tree with a cavity in the trunk is worth saving for birds. It can be cut off above the hollow and a new tree planted nearby instead of cutting the old one off close to the ground. After serving as a bird home for a few years, it can be removed. In replacing old fence posts, it is well to put in a new post but leave the hollow one for bluebirds, wrens, and other cavity-nesting birds.

At the time of cultivating orchards the farmer can make them more attractive to birds by planting sweetclover or small grains to be left unharvested. In addition to checking the growth of weeds and preventing erosion in the orchard, these will furnish food and cover for wild birds and animals. Seed of such cover crops may be disked in.

If rabbits are damaging the orchard in winter, it may be well to try feeding them away from the orchard, instead of killing them. In many cases rabbits are driven to orchards because the only readily available food supply is there. When pruning orchards, it is a good plan to pile the pruned branches in coverts so that the cottontails will feed on these instead of on the trees. The uneaten parts can be burned in spring.

ORNAMENTAL SHRUBBERY AND TREES

The season-long succession of flowers and the year-round show of ever-changing colored fruits that can be had by judicious planting of shrubbery are sufficient reasons for such planting on the farm. The utility that shrubbery has for wild life, however, is an important additional urge.

Ornamental shrubs and trees provide a large part of the food for wild mammals and birds and many nesting sites. In farm plantings, it is especially necessary to bear in mind certain undesirable traits of shrubs, such as the connection between buckthorn and oats rust, barberries and wheat rust, redcedar and apple rust, and currants or gooseberries and white-pine blister rust. Wild cherries furnish nurseries for tent caterpillars, pests of orchards. In general, therefore, these shrubs should not be planted in regions where the injured crops are cultivated. There are, however, a host of satisfactory substitutes.

Recommendations regarding the kinds of shrubs adapted to various regions are contained in the following Farmers' Bulletins: No. 621, How to Attract Birds in Northeastern United States; no. 760, How to Attract Birds in Northwestern United States; no. 844, How to Attract Birds in the Middle Atlantic States; and no. 912, How to Attract Birds in the East Central States. The landscaping phase of shrubs and tree utilization is treated in Farmers' Bulletin 1087, Beautifying the Farmstead.

Fruit and nut-bearing trees can be planted as individual specimens for ornamental purposes or merged in wood lots, windbreaks, and thickets to improve the coverts from the standpoint of the welfare of wild life.

In the course of the southern cooperative quail investigation it was found that plum thickets were havens of refuge for the birds and that each thicket, if adjacent to suitable nesting and feeding areas, could be made the headquarters for a covey of quail. Through research in Wisconsin it was learned that thickets in draws and gullies, in addition to moderating erosion on farming lands, are of vital importance to coveys of quail.

Another interesting feature of game-planning work brought out by the cooperative quail investigation was the fact that although food might be produced in abundance, it might easily become unavailable. For example, pine seeds, or " mast ", might fall in ground cover so dense that they could not be found by quail. Inasmuch as these birds rarely or never fly into the trees to procure such seeds, better results were achieved, so far as game was concerned, by preserving trees in places where the ground was fairly clear, as in a pasture adjacent to good cover. For this reason, an isolated fruit and nut-bearing tree, even though in a grazed pasture or other exposed place, frequently plays an important part in furnishing food to wild birds and animals, and should not be cut down merely because it is not surrounded by good coverts.

ROADSIDES

In many parts of the United States, roadsides are shorn of their vegetation at least once a year, either as a result of local sentiment or of legal requirement. Consequently, many country roads are very uninviting in summer. Hot and gray with dust, these highways stretch out before the traveler, often without a single tree to break the monotony of the view or afford relief from the rays of the sun.

Fortunately, there are also in this country examples of well-kept parkways and boulevards (fig. 10) bordering cultivated lands. Their ample parking is grown to grass and embellished with herbaceous flowering plants, shrubs, and trees. Yet the farm lands they border are neither overwhelmed by weeds nor devasted by insects and rodents. Placing vines upon fences and planting numerous shrubs and shade trees along the way will not only render the roads more attractive (fig. 11) but will tend to keep down the dust. Roadside plantings are discussed in Farmers' Bulletins 1481, Planting the Roadside, and 1482, Trees for Roadside Planting.

There can be no doubt that suppression of roadside vegetation is a potent factor in restricting the number of birds, and the ever-increasing tendency to allow fence rows the minimum of space has the same effect. Farmers may gain a planting row about every field by the destruction of vegetation along fences, but they lose the services of the birds, their best allies in fighting insects.

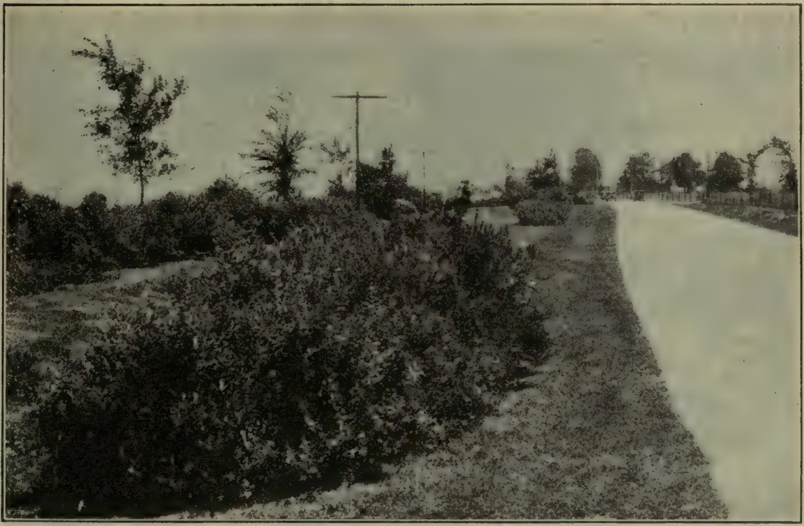
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FIGURE 10.—A roadside attractively developed. Particularly good for songbirds, but of some use for quail and pheasants. (Photo by Wayne County (Mich.) Board of Highway Commissioners.)

Shrubby fence rows are among the best harbors and nesting places of small birds, and it is certain that encouraging an abundance of birds to live on farms is a profitable policy. More should be done to beautify roadsides and fence rows, not only as a measure contributing to the comfort and pleasure of man, but also as substantially increasing a great economic asset—the bird population of the country.

COVER IN RELATION TO PESTS

WEED PROBLEMS

So far as the relation of windbreaks, hedgerows, and thickets to noxious weeds is concerned, it should be pointed out that many weeds are not shade resistant and die out in thicket growth, and the roots of many are not able to withstand the competition of grass roots or sod. It is also of interest to note that some of the prairie States, which have many large areas without any between-fields cover, have the most serious weed problems. Where weeds do occur locally in numbers in windbreaks or hedges, cutting the weeds prior to seeding time will keep them from adding more seeds to the already abundant supply.

One common objection to weeds is that they have no productive use, but many, such as ragweed, amaranth or pigweed, lambsquarters, and smart weeds, materially increase the food of wild birds and animals, and hence are really useful in their place. Ragweed, though objectionable as a cause of hay fever (see Leaflet No. 95, How to Control Ragweed, the Principal Cause of Autumn Hay Fever), is of primary importance as a winter food for quail. It follows cultivation but does not come into full growth until after harvest time. Patches left near cover will feed many birds. The plant holds its seeds well, stands up in the snow, and is a staple food of song and game birds. If due care is taken to prevent unreasonable spread, patches of some of the less harmful weeds may be deliberately encouraged for bird use. This, of course, does not apply to such extremely obnoxious weeds as the Canada thistle and Russian thistle.

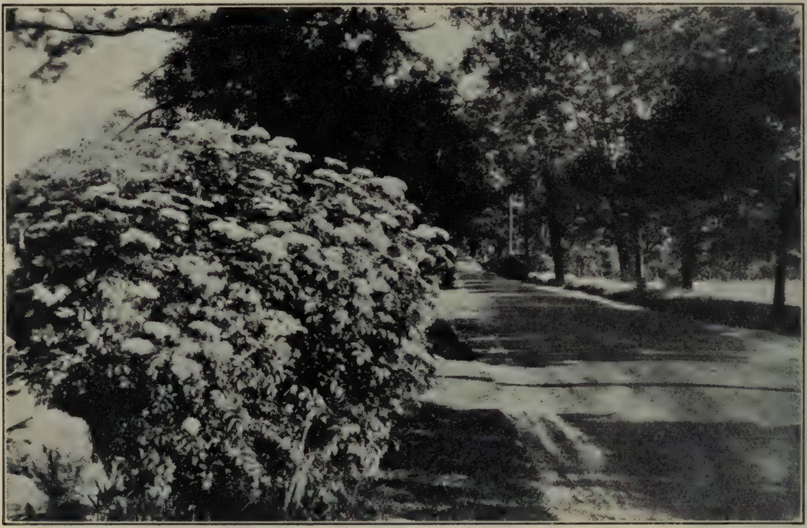
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FIGURE 11.—Roadside bordered by elderberry. Illustrating how highways may be made attractive to man and wild creatures alike.

RODENT PESTS

Grassy and brushy areas left between fields for bird cover should not be allowed to become dense and matted, as this type of cover not only is less favorable to birds but also is likely to harbor and favor the increase of rodent pests. In addition to menacing adjacent crops, rodents may become serious food competitors of game birds and destroyers of their eggs. Also, the presence of numerous rodents attracts a proportionate number of their enemies among snakes and predatory birds and mammals, and these incidentally may also become destructive to the eggs and young of ground-nesting birds.

Cotton rats in Southern States and meadow mice generally are especially responsive to favorable habitats, such as are afforded by areas of dense broomsedge, brier thickets, and other cover that provides them protection and food. In such cases they may do serious damage to adjacent crops. Cotton rats have also been known to destroy bird eggs. House rats sometimes take advantage of the protection afforded by overgrown ditch banks and fence rows, even far from human habitation, and in such situations they may become destructive to the eggs and young of birds.

Poisoning rodents is often indispensable to successful propagation of beneficial species on noncultivated areas. Information concerning the most practical methods of destroying rodent pests can be obtained by writing to the Bureau of Biological Survey, United States Department of Agriculture, Washington, D.C.

INSECTS

Hedgerows and other cover types provide homes for many insects, some of which are pests.

Cover, however, does much to justify its maintenance by harboring some of the most important groups of insect enemies, our beneficial birds. Thickets, hedges, roadside cover, and grass areas, all play an important part in making a place attractive to birds. In fact, the brown thrasher, the catbird, kingbird, goldfinch, many warblers, the quail, and a number of other beautiful and attractive birds are ordinarily found in thicket cover, but generally not where it is absent. The extension of thickets between fields is a practical way of enticing valuable birds out into the crops, as they range to either side of the cover. Cuckoos, for example, which eat " furry ", or hairy, caterpillars, will follow such hedgerows extensively, but will not follow field borders if there is no shrubby or wooded cover. Pheasants, Hungarian partridges, quail, prairie chickens, and, in fact, most of our game birds, are fond of grasshoppers, corn billbugs, and many other destructive insects. The birds should therefore be enticed into crop areas by an attractive environment. Unlike man-made agencies of control, birds continue their activities throughout the seasons, and they work in and through crops where man cannot go. The downy woodpecker has been seen taking borers from cornstalks in winter, thus contributing toward a good crop the following summer.

Scores of instances are known in which birds have suppressed local outbreaks of insect pests, and while their work in insect control is not always so spectacular, it is a steady aid that the farmer should always encourage. It is certainly good agricultural practice to maintain an environment that will attract and hold the birds that are such effective enemies of insect and other pests.

The word "insect" should not bring to mind only a vision of destructiveness, for many kinds of insects are beneficial to man. For instance, one useful service performed chiefly by insects is the pollination of fruit and other crops, which is necessary to their productivity. An example among field crops is the red clover, which is most often pollinated by the bumblebee, a common insect that is little appreciated. According to the Yearbook of Agriculture, 1928, p. 524—

> In many localities there has been an alarming decrease in the amount of seed [red clover] set from fields where large yields of seed were expected. This decline may be attributed to a decrease in the bumblebee population, brought about by extensive campaigns to clean up fence rows, the plowing of permanent meadows, and the clearing of wood lots, all of which measures tend to decrease the number of bumblebees' natural homes. A continual decrease in seed production in the future may be expected where such activities are carried on.

Other sorts of useful insects find shelter in the comparatively undisturbed cover, among them some that combat injurious insects. It was recently shown, for instance, that in Wisconsin the ravages of a pea aphid, or louse, that sucks the sap from the growing vines of cannery peas and attacks other crops, were much less severe, and in some cases practically negligible, adjacent to open woodland. Such cover harbored syrphids, or flower flies, which are important enemies of the pea aphid. The effectiveness of the protection extended a considerable distance from the cover.

MARSH AND WATER AREAS

GENERAL VALUE

Drainage in agricultural districts has been carried on so systematically that the farm with marsh, pond, or perennial stream is exceptional. The scenic advantages of water, however, are universally admitted, and there is no other one thing that permits, or of itself brings, such a diversification and abundance of plant and animal life. Many of these forms are of economic importance to the landowner. All are of interest to him and to his family. Early in spring a pond may draw down from the skies some of those mysterious voyagers, the waterfowl; a little later flocks of swallows with airy circling and graceful dipping will so weave a maze of flight as to charm all beholders; in summer, a rail or coot, or even a wild duck, may bring forth from the reedy margin a fluffy brood that will be the pride of the farmer's heart; in fall, the muskrats may be seen building the conical houses they will need for winter shelter; and in winter the frozen marsh will reveal after every snow a fascinating story of the movements of both furred and feathered wild life.

The farmer who has provided for water areas has also solved his stock-watering problem, but in using this advantage he should guard against gross pollution, if threatened. Similarly, if he keeps domestic ducks in any number, their pond should be isolated to prevent pollution of other water supplies. Such action is especially important where ice is to be harvested, but the water supply should be kept clean for the sake of wild life as well. It will be more productive of wild life of every kind, including fishes, if uncontaminated.

IMPROVEMENT OF AQUATIC ENVIRONMENTS

MARSHES

Marshes of almost any size are of value to wild life, but they can be quickly ruined for this purpose if freely ranged by hogs or cattle. If the marshes must be devoted in part to domestic animals, effective fencing should preserve a fair share of the total area for wild life. If one or more ponds are present, or can be made by damming the drainage channel or by dynamiting in the body of the marsh (a simple process), much greater improvements can be made for wild life. (See the discussion of ponds, p. 28.) In all cases where the marsh tends to dry up in summer, the channel should be dammed sufficiently to prevent that calamity to all life dependent upon it. The fine fall and winter cover should not be destroyed by burning. If fire must be used, the marsh should be burned early in spring.

A wet, grassy marsh can be transformed in whole or in part into a wood lot by setting out tamarack, black or red spruces, or other moisture-loving trees. Spruce is used for many purposes, including posts and pulp, and tamarack has many farm uses. Converting half of a grassy marsh of large extent into a wood lot and leaving the rest as it stands, or adding some willow, alder, and red-osier dogwood, will literally make the area a paradise for game and fur animals as well as for songbirds.

Cattails and bulrushes usually are present in marshes; they are good cover plants for the nests of red-winged blackbirds, rails, coots, bitterns, and ducks, and their roots provide first-class muskrat food. Barnyard grass (called also wild millet, water grass, and numerous other names) often is present as a weed about marsh borders. It is a good food plant for a variety of wild life, is easily propagated, and the seed is cheap. Information on the improvement of aquatic environments by propagating duck foods may be found in Department of Agriculture Bulletins 205, Eleven Important Wild-Duck Foods, and 465, Propagation of Wild-Duck Foods. The Bureau of Biological Survey will supply applicants with addresses of dealers in wild-duck food plants.

STREAMS

Streams are improved for wild life if pools or quiet reaches are made to alternate with ripples or small rapids. If not naturally present, these can be provided by installing a series of rude partial dams or other obstructions. Small marshes can be made at the edges of the slack-water portions by a little excavation at such points. In general, food for the larger forms of aquatic life is produced in the quiet places, and its overflow to the more open moving water is a source of subsistence depended on by the numerous creatures that forage there.

A trout stream can be improved by supplying plenty of overhanging vegetation, which serves (1) to lower the temperature of the water to a degree more habitable for trout; (2) to add more insect food for the trout; and (3) to provide refuge places. Willows are excellent for this purpose, and also make good game cover. In woods, the dogwood and the cranberrybush (sometimes called highbush cranberry) may be planted. Willows may be started by cutting "whips" in spring and sticking these, cut end down, in moist soil. (For planting larger willows see p. 19.)

Streams with soft bottoms in quiet water at a depth of 1 to 5 feet and with fair exposure to sunlight, can be stocked with some of the more valuable aquatic plants, such as wild celery, and sago and other pondweeds. In certain cases streams can be impounded to form ponds.

PONDS AND LAKES

Muskrats, mallards, teals, rails, terns, and shore birds, as well as many songbirds, delight in the small pond or shallow lake. With an adjoining marsh (provision for which should be made where it does not already exist), a pond or lake furnishes or can be made to furnish all the essentials of existence for most of the forms of wild life of aquatic environments; in general, marshes provide cover, and ponds forage. A little work with plow and scraper will pave the way for a marsh at the margin of any pond. Marsh vegetation will come naturally to such a place, but progress can be hastened by transplanting, which often can be done from nearby sources. Such marshes should be protected by fencing when necessary, for grazing is destructive and should not be permitted there. The pond, if not already well stocked with plants, can be planted to a number of good duck-food plants, which are described, together with methods of propagating them, in the bulletins previously cited (p. 27).

The wild life suited to these areas will recruit itself. A marsh of even diminutive proportions will tempt a pair of red-winged blackbirds to nest. These birds are a colorful addition to farm life during a long season. Though muskrats do not require extensive areas, their presence should not be encouraged near root crops. Rabbits, pheasants, and quail use marshes more or less, although they do not ordinarily breed there. As marshes grow in area and in depth, rails, coots, bitterns, and even wild ducks come in. Where an increase of Wilson's snipe (jacksnipe) is desired, a closely cropped clover sod growing among soppy hummocks and hollows should be encouraged. Muddy flats also are attractive to jacksnipe and other shore birds. Geese like to rest on sand bars. If the pond does not have a sand bar and is fairly shallow, one may be built up over a nucleus of rocks, in a place where the geese can rest in isolated comfort. On some game refuges this has been done to advantage.

Waterfowl may be considered a prize among farm wild life, and the aid of farmers in reestablishing colonies of these birds over a vast breeding range now largely deserted would be a wonderful step in insuring their preservation. These birds learn quickly where they are unmolested. There are few more interesting groups of birds to observe, and hundreds of individuals can be drawn into ponds of very small size if protection and food are provided. Colonies can be started by placing pinioned pairs on the ponds or by having domestic ducks hatch the eggs of wild stock. Once started, such colonies persist with only a little feeding. Regularly fed, they can, where they occur in numbers, be depended upon as a source of farm income through the disposal of shooting privileges, if the birds are kept wild enough. Feeding must not be overdone, however, or the birds will tend to lose their wild form and vigor; its real use in this connection is to cause a strong attachment to the home pond. In general, the ducks should be encouraged to forage for themselves. Some wild ducks domesticate readily, and for this reason it is especially desirable that colonizing efforts be attempted only with the best of wild stock, free from any domestic mixtures, and that attempts to make pets of them be discouraged.

Snapping turtles are duck destroyers, often killing the ducklings, and the larger "snappers" even overpower and eat adult ducks. Shooting with a .22-caliber rifle, seining, and trapping are recommended for turtle control. (See Farmers' Bulletin 1612, Propagation of Aquatic Game Birds.) Turtles lay their eggs in sandy spots during spring and summer, sometimes making extended migrations for this purpose. Although skunks and other fur animals eat these eggs, systematic search and destruction of them by man is a desirable means of control.

The various herons, or "cranes", and the bitterns that are found in wet areas should not be molested. Their food consists mostly of undesirable fishes, crawfishes, frogs, tadpoles, mice, and aquatic insects, some of which eat small fishes or fish spawn. Destruction of herons to improve fishing is almost always ineffective. Moreover, these birds are protected by Federal law.

The pond or lake is not a place to dump rubbish, and such dumping is contrary to law in many States. Old machinery, cans, glass, and junk should not be hauled out upon the ice and left to sink out of sight when it melts. Pollution in any form should be avoided. Sewage should not be diverted into small ponds or lakes; it endangers human health and is a menace to wild life. Cannery, creamery, filling-station, or oil wastes should never be diverted into waters that are expected to harbor birds, mammals, or fish.

Most States have laws or regulations affecting the propagation of game birds, and many require game breeders to take out licenses. In addition, Federal permits are necessary for lawful possession of wild ducks, wild geese, swans, and other migratory game birds in captivity. Federal permits are obtainable through the Bureau of Biological Survey, United States Department of Agriculture, Washington, D.C., as are also the addresses of officials to whom application should be made for State licenses and for the full text of State laws relating to the propagation of game birds.

CULTIVATED CROPS

The 370,000,000 acres of cultivated crops in the United States afford one of the most suitable of wild-life environments, though for various reasons they are comparatively little used by the creatures of the wild. The value of these lands for birds or animals varies with the crop, the methods of handling it, and the locality. By and large, it must be said that the crop environment does not ordinarily have a high population of wild life except in portions adjacent to good coverts (fig. 12). In most cases, also, where this fortunate proximity of cultivation and covert exists it is only by chance. Inasmuch as a general increase of wild birds and animals upon farms is of direct benefit to agriculture, it is surprising that so little has been done toward promoting those farm practices which benefit wild creatures and at the same time are practical from the cropping standpoint.

RELATION OF FARM PRACTICES TO WILD LIFE

No single factor is more important for wild-life welfare than farm practices. Songbirds, game birds, and fur animals exist on farms only where farm practices preserve their homes, provide dependable food supplies, and afford protection from natural enemies and man. The farmer who wishes to encourage valuable wild life on his premises need not seek help beyond his own fences. Enough of the essential factors are already within his control to give him power to increase or reduce the numbers of practically every kind of bird or animal on the farm.

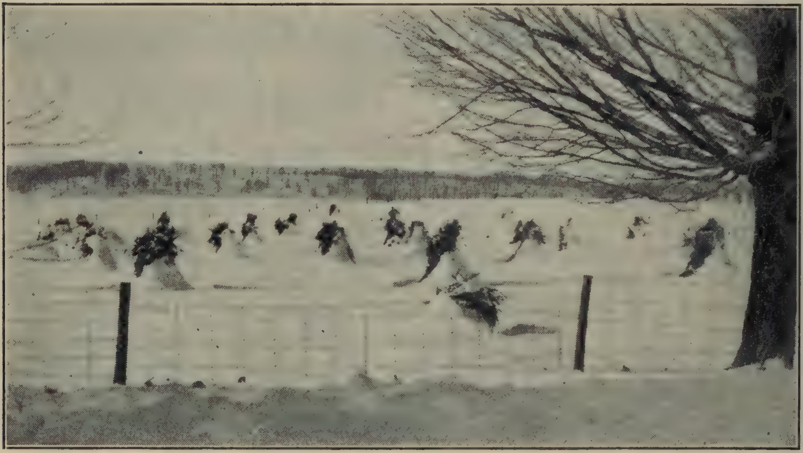

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FIGURE 12.—Winter in a northern cornfield. Conditions all too common: Little or no winter cover; and food largely unavailable. In the center of the picture, Hungarian partridges may be seen at the base of a corn shock. The best method of winter feeding for these birds would be to open up one or more of the shocks. Cover could be afforded by constructing a tepee of cornstalks.

CULTIVATION AND HARVESTING

The far-reaching effects upon wild life of farm practices are shown by the abundance of the ring-necked pheasant in parts of the Corn Belt. Investigation shows the number to be greatest in areas where farming methods afford birds the best combination of food, cover, and protection. In South Dakota, for example, where much of the eastern part of the State is given over to large-scale production of corn, it is the common practice to turn cattle and hogs into picked or standing corn to feed until severe weather. With literally miles and miles of standing corn in South Dakota, a great quantity is available for the pheasants. Furthermore, even where the corn is first harvested, either by machine picker or by hand, and the livestock are not turned in until picking has been completed, many small nubbins and a great quantity of spilled grain are available to the birds throughout the winter.

There is little natural cover in much of the eastern South Dakota farm environment. Pheasants depend largely upon standing crops for their cover, perhaps the most important of which is the corn with its associated weeds. Standing corn, then, furnishes the birds both food and cover, particularly where the fields are fairly weedy, as is often the case in large-scale farming. Such farming practice has proved capable of maintaining a large population of pheasants, larger probably than that in any other State. Investigation has shown that pheasants do considerable good by feeding on insects; furthermore, these birds may serve as a source of delicious food for the table during the open seasons, in these ways repaying the farmer for the grain they have eaten.

In some other Corn Belt States the system of farming includes the production of milk and dairy products. This involves intensive utilization of corn for dairy feeding. The practice is to put as much of the corn in silage as the farmer has facilities to handle, and to haul the rest of the crop from the field shocks as needed. There is practically no late standing corn in most of the silo region, and in many counties by midwinter there is even very little shocked corn in the field. Consequently, the ring-necked pheasant either is absent or lives in restricted areas of natural cover, subsisting largely on natural foods, which usually are not abundant in the intensively farmed areas. It is apparent, then, that the same crop that produces an excellent environment for pheasants under one method of handling may be of much less value under another.

The practical application of this information is to modify agricultural practice slightly where it is desired to increase pheasants. Farmers have found that leaving a half-acre patch of standing corn adjacent to the farm wood lot or to an unburned marsh brings a pleasing increase in the pheasant or other game-bird population. Some of the shocked corn might also be left in the fields, the shocks opened to afford refuge to game in case of emergency. Even such a slight modification as the hauling of shocked corn first from those fields farthest from cover, leaving the shocks next to woodland and marsh until the last, has a great influence upon the welfare of game. So also, starting the harvesting of hay or small grains in that part of the field farthest from cover and working toward the cover, instead of driving game into the center of the field by circling it, will be an easily arranged benefit to the birds. The small amount of grain eaten is negligible, compared with the advantages obtained from having the birds about.

Practically all farm crops have some value to wild life if handled with this purpose in mind. Hayfields and small-grain fields are commonly used for nest sites by quail, pheasants, and Hungarian partridges, as well as by meadowlarks. Sweetclover, corn, sorghum, sunflowers, and miscellaneous crops afford good summer cover, and if patches are left standing they give cover protection and some food to game and small birds even in winter. Strips equal to one or two widths of the harvester left uncut adjacent to cover are not much missed and mean a great deal to the wild life of the farm. Stubble is noted as a fall gathering spot for many game birds, attracted both by waste grain and by grasshoppers, which may be plentiful in it. Stubble can be made more useful as cover if the cutters of the harvesting machines are set high, or a "header" machine may be used if the straw is of no particular value. Measures for decreasing the mortality caused by farming operations are discussed on pages 42 to 44.

In some cases the farmer will be able to benefit directly both himself and the birds by planting sweetclover. It is an excellent soil builder, helps to smother weeds, checks erosion, and makes good forage. It furnishes some food to numbers of birds, and makes excellent cover for pheasants and other game. It may be planted (1) next to corn that is to be left standing, (2) next to any good natural cover, (3) along roadsides newly graded, (4) around or in old gravel pits, (5) in eroding gullies, washes, and wind-drifting soils, and (6) in any other places on the farm that are not being cropped and that are not intended for trees, windbreaks, or hedges. Sweetclover is sometimes planted with corn, left in the field through the winter, and plowed under in spring; this is excellent for wild life during the most critical season of the year.

Some clover may be profitably grown for seed, as considerable red-clover seed is still imported. Seed crops are not cut until later than ordinary hay, and this gives game an opportunity to rear young and get them away before cutting time. If possible, the seed clover should be arranged in long strips next to cover instead of in one large field.

Orchards are among the best of environments to be found for songbirds upon farms, and gardens are another favorite bird resort. Mention has already been made (p. 29) of the added value as game harbors of crops bordered by woodland, marsh, weedy field, or other permanent cover.

Where green manuring is extensively practiced for soil-building and other purposes, fields so used may become the main dependence of game birds and thus result in a material increase in their numbers. A definite rotation system for each group of fields, or better still for each group of farms, may easily be worked out, and the soil-enriching process greatly assisted, by planting nitrogen-fixing crops, such as clover, peas, soybeans, vetch, alfalfa, sweetclover, or any of the other leguminous crops recommended by the State agricultural college for the locality in question. It should, of course, be remembered that these green-manure crops should not be plowed under at a time when plowing endangers nests, and that the value of the fields may be much enhanced, from the wild-life standpoint, if ample strips are left unplowed until spring. Such areas may be the most commonly used of farm nesting sites and afford almost ideal conditions for birds rearing young, provided the fields do not become too densely overgrown. They are resorted to in winter as places of refuge and plenty and by careful planning may be made a most important means of maintaining soil fertility and at the same time producing a crop of wild life.

Idle weedy fields, if not too dense, often have considerable value as feeding and breeding places for game and insectivorous birds.

In this connection, it is well to emphasize again the importance of diversification. Where farming operations are carried on with wild-life and game development in mind, it is well to arrange the fields in long narrow strips, rather than in solid blocks, the strips extending within reach of all available cover types on the property. In this way one can obtain even within restricted areas, the maximum diversification of nesting, shelter, and emergency cover, as well as of greens, grains, and insects. The strip system was effectively developed by the cooperative quail investigation, in the course of which deliberate effort was made to border the strips with good cover. Alternating cover and crops in long strips really multiplies by many times the number of quail-covey ranges available on a given property. How far it may be carried on the ordinary farm will depend upon objectives and the presence or absence of diversified conditions at the start.

A list of farm practices that may be favorably modified for game and other wild life is found elsewhere in this bulletin (p. 42). Reference to it will suggest many other practices subject to improvement from this standpoint. In general, it can be said that pheasants and Hungarian partridges are exceptional in their ability to survive on highly cultivated land; most game birds require more cover than is afforded by ordinary farm crops alone. By taking full advantage of the natural areas remaining on the property, however, and by arranging the cropping practice with the game potentialities in mind, nearly every farmer can increase greatly the wild birds and animals on his farm, without in the least handicapping his production of the more staple agricultural commodities.

INCREASING THE FOOD SUPPLY FOR WILD LIFE

NEED FOR A CONTINUOUS, UNFAILING SUPPLY

Not only is food one of the most important factors affecting wild life, but fortunately it is also readily susceptible to control. Though the wild-life food supply can be increased to any desired extent, it is pitifully true that on the average American farm it is extremely scarce, at least during critical periods, as late in winter. Maintenance of an abundance of wild life in general or, more concretely, of a resident form like the bobwhite, depends upon unfailing continuity in the food supply. There must be food on the farm at all seasons, for if even one season is barren, wild life must seek sustenance elsewhere. The food supply must be a year-long chain, with no weak link.

In some cases, though the natural food is abundant, birds are unable to procure it. The cooperative quail investigation noted, for instance, that much of the native-legume seed, an important natural food of quail in the Southeastern States, fell into and through the dense mat of broomsedge and grasses that covered the soil, and could not be obtained by the quail, which are relatively weak-footed and inept at scratching. A certain type of ground cover (see p. 9) can thus result in partial to almost complete wastage of the excellent foods produced. The condition must in many cases be corrected, if the wild-life food supply is to remain ample. On northern farms it is probable that such wastage is most pronounced in marshes grown up to dense sedge and grass, in fallow fields left uncultivated 2 or more years, and in woodlands that have accumulated a dense mat of fallen pine needles. Plowing and disking in intersecting strips is probably the best means of control, particularly as a rich volunteer growth of food-producing plants is often obtained on the turned strips. Where ample precautions are taken, fire can be a most effective tool in controlling such ground cover, but its proper use calls for full knowledge of its effects upon various types of vegetation. It may be possible to burn narrow strips through woodlands when the dew is on the vegetation, but the fire must be kept slow and of reasonable size.

SUMMER FOOD

The summer foods of wild farm birds and mammals consist largely of insects, fruits, berries, and succulent green vegetation. Summer, barring drought, is a season of plenty. Nevertheless, wild things have their preferences and, regardless of a general condition of plenty, are attracted to spots where their favorite foods occur. Successful game managers see to it that fruits and berries are available in a considerable variety and abundance. Insects are favored by dense vegetation and a plentiful water supply, and on farms for upland game birds the rearing fields for young birds are specially planted and managed to produce an abundance of insect food.

FALL FOOD

Many insects continue to be available to game until fairly late in fall, and dry grapes, fall-ripened berries, acorns, and some greens are to be had in that season in considerable abundance. By midfall, however, the food supply is largely beyond natural replenishment; future consumption is taken out of stock. Consequently, it is essential that an adequate stock be on hand to last through the winter and spring. It commonly happens that the supply of naturally stored food, in the form of weed seeds, dormant insects, dried berries, grains, and greens, diminishes rapidly until it is almost entirely exhausted, or until snows and other climatic factors make it unavailable. By the advent of real winter, farm food supplies for wild life are frequently seriously deficient, a condition all the more regrettable in view of the ease with which they can be increased. Fruit-bearing shrubs holding their crop over winter are available; they can be provided in any quantity, and the gain in food production for wild life is permanent.

WINTER FOOD

After winter has set in it is common for wild birds and animals to be faced almost daily with the serious problem of getting enough to eat. Some fur animals and other mammals evade this difficulty by hibernating, existing upon the fat stored up from fall, but song and game birds do not. Even for the muskrats in the marshlands, winter may be a severe ordeal if the water supply is deficient or other factors are adverse.

Game wanders to some extent in times of stress, and if it must leave the farm on which it has been living to search elsewhere for supplies of food, that farm loses thereby, for if game succeeds in finding a place with a good food supply, it is likely to remain there. Wandering for food, however, often is not successful, the birds failing to find any more favorable situation than they left. Some individuals die outright when the food supply is low, pinched off by cold and storm as their constitutional vigor becomes reduced through hunger. Hawks and owls carry off others that if properly nourished would be able to escape. Without the warmth and vigor produced by food, wild creatures are at the mercy of the elements and their enemies. All the eliminating agencies of nature combine to destroy the individuals that lack food or are otherwise weakened. On the other hand, if cover and food are ample, climatic factors may be negligible, although in exceptionally unfavorable years they may cause a somewhat reduced yield. Sound wild-life management demands the saving of birds and animals that would otherwise perish, increasing them, and later putting them to whatever use may be desired.

WINTER FEEDING

Winter feeding is one of the most effective game-conservation measures at the disposal of farmers or game managers. It has become a standard practice with game commissions in various parts of the country. In the past much of it has been of an emergency nature, often wasteful and ineffective because done without advance preparation and consideration of the difficulties involved. Too often emergency feeding is attempted at a time when all transportation is difficult and laborious, or even impossible. Yet one can plan in advance and avoid such difficulties. (See Miscellaneous Publication No. 159, Winter Feeding of Wild Life on Northern Farms.) Moreover, farmers and resident game managers have a strategic advantage of location that the best of intentions and even substantial sums of money cannot obtain for nonresident conservationists. Planned winter feeding of game, in fact, can be a very simple process, easily and effectively done by any farm boy or other person interested in increasing wild life. Some of the most effective ways of feeding are to provide unharvested standing corn (fig. 13)

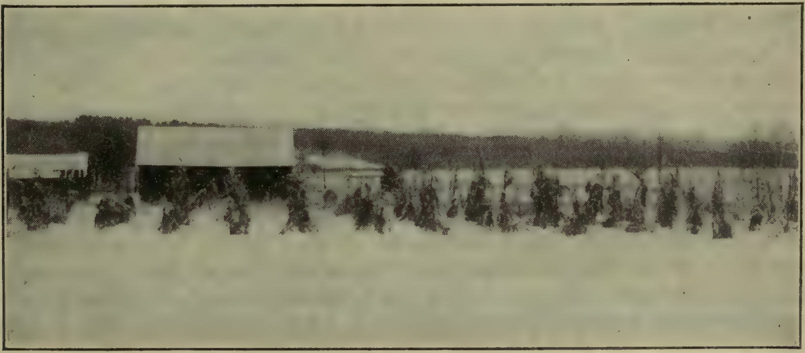

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FIGURE 13.—A patch of standing corn left for game by a Wisconsin farmer. Prairie chickens, ring-necked pheasants, and winter field birds and rabbits were feeding here just before the photograph was taken. This feeding station is a little too near buildings and is none too large. It would be more useful if near good cover.

near good-cover; shocks of unhusked corn, which are opened regularly and reconstructed in tepee fashion; unharvested small grains; and unthreshed small grains left in the sheaf and stored for the purpose.

All these provisions are simple. Sheaf grain can be set out in the snow, and grain to be left standing can be planted in places where feeding will be most effective. Standing, shocked, or sheaf grain (corn, wheat, buckwheat, sorghum, millet, and other small grain) is preferable to loose shelled grain. If shelled grain is used, it is well to construct corn-shock or brush shelters, providing both shelter and food and at the same time plenty of openings for escape in emergencies. Greens, such as alfalfa-leaf meal, hay screenings, or lettuce scraps, will generally be relished by winter birds. A small plot of winter wheat will also supply a green food attractive to many. In years of great abundance of certain grains, those for which there is most likely to be an unmarketable surplus can be used, and thus help, even if only in a small way, to maintain satisfactory price levels. Careful planning should characterize all feeding operations, with due attention, where local conditions are known, to areas subject to heavy drifting of snow and to those usually affording the more favorable exposures. Advantage should be taken of windbreaks, sunny exposures, south-facing hillsides, packed roads, and other favorable features. Food should be provided regularly, and the supply should be dependable over long periods; deficiencies are cumulative, but even a day or two without nourishment may prove serious.

It sometimes occurs, particularly on areas managed for game birds, that if there is too great an abundance of rodents, including rabbits, squirrels, and mice, much of the winter feeding supports these species rather than the game birds. Here, too, planning is necessary, and the situation may be anticipated and thus easily handled, at least when rabbits and squirrels are troublesome, by permitting adequate hunting upon the property during the regular open seasons. As to mice and rats, mention has already been made of the advantage of encouraging beneficial hawks and owls (which also assist in checking rabbit and squirrel increase), and this subject is further treated elsewhere (p. 44). Where the small-rodent situation in field and orchard demands more serious attention, poisoning operations, as recommended in Farmers' Bulletin 1397, Mouse Control in Field and Orchard, may be necessary. In this case, strychnine is preferred, as poultry, quail, pheasants, and other gallinaceous birds are resistant to its effects. This partial immunity does not extend, however, to other birds; hence, care should be exercised at all times; poisoned baits can be put out in containers that only small rodents can enter. To make sure that the food supply is dependable, the farmer must also keep livestock away from feeding stations, by fencing if necessary.

Emergency feeding measures, when required, may include shoveling through the snow to the earth and scattering grain on the exposed ground; building brush or cornstalk-tepee shelters and placing grain inside; distributing shelled grain on hard-packed sled roads where automobiles are not common; or taking other steps that local conditions may suggest.

In sections affected by the corn borer, sheaf grain is recommended, or ears of corn impaled upon spikes driven through boards, which are then set upright in the snow. Ears of corn may be hung from barbed-wire fences, in hedgerows, or from limbs in good brushy growth. Conscientious cooperation with State and Federal agencies in corn-borer eradication should at all times be maintained. In many cases those in charge of such work will be glad to help devise satisfactory methods of feeding game, if a conflict in practices exists.

The winter feeding of small birds is used as a means of keeping them about orchards, where they destroy numerous hibernating insects. It is also done by many people to bring birds to a convenient place (often a window shelf) for observation. Suet is the principal attraction for birds of carnivorous tastes, such as the woodpeckers, nuthatches, chickadees, and creepers; and bread scraps, scratch feed, and sunflower and other seeds for the granivorous birds, including juncos, song sparrows, crossbills, finches, and many others. Fruit eaters sometimes will come to quartered apples, soaked raisins, or partially dried grapes. Directions for winter feeding of small birds are given in farmers' bulletins referred to on page 22.

As ornamental shrubbery can be made to serve the dual purpose of providing beauty for man and food for birds; so, also, can some of the cultivated flowers. Sunflowers, goldenglow, cosmos, and related plants hold their seeds fairly well and are greatly relished by various birds. Other common flowers of value to seed eaters are princesfeather, love-lies-bleeding, forget-me-nots, and poppies. Millets are excellent for planting to feed wild birds.

SPRING FOOD

Spring makes available some fresh greens, and during this season there are also to be had fallen seeds and some insects that were previously covered by snow. Early in spring, however, it is surprising how dependent many birds are upon grain. It is good practice to keep some grain available until the advent of the new generation of insects. In well-diversified game country the spring food supply is usually ample, but where more uniform conditions prevail, spring foods are likely to be deficient. Game coverts, for maximum spring utility, should have many nut- and seed-producing trees, berry patches, greens, and an abundance of insect-harboring vegetation. It is to be remembered also that by spring some hard foods ordinarily will have been softened enough to be usable even though earlier they were not edible. Cherry pits, which in summer pass through the birds entire, are eaten freely and the inner meat digested early in spring when cracked in the sprouting process. Many fallen berries and other fruits, which were passed by late in summer and fall, are also picked up in spring. The corky Japanese barberry is an example of a fruit not taken in fall but eaten in the softened condition it attains in spring.

It is well also to remember that threats to growing crops by game birds during this season can usually be taken care of without driving the game clear off the farm. If pheasants, for instance, concentrate upon a sprouting cornfield and cause local damage, a little corn soaked overnight and scattered over the ground in the worst areas will generally check the damage at slight cost, without destroying the birds. With the interest of the birds in mind, the farmer will be able to find similar measures for dealing with other emergencies of this sort. Often, adequate food resources on uncultivated areas will be all the protection needed for crop lands.

INCREASING THE NATURAL FOOD SUPPLY

PLANTING

It is fortunate that wild creatures utilize many of the same trees, shrubs, and vines that are so highly prized by people for ornamental use, for it is possible to accomplish farm adornment and wild-life attraction at the same time. Though many of our ornamental plants bear seeds and fruits that do not supply wild birds and animals with food throughout the entire year, plantings can be made in such a manner that the fruiting seasons overlap, and thus food may be made available throughout the year. Moreover, valuable food plants will volunteer in the waste places of every farm, if these are protected from grazing and fire, or in some cases, if sod-bound areas are plowed.

Anyone would rather live on a farm where birds are abundant than on one having only a few. The presence of trees, shrubs, and vines, by attracting bird life, will add color throughout the year. Dumping grounds, full of tin cans, wire, and refuse, as well as quarries, gravel pits, old cellars, and other unattractive spots may be screened by planting trees and shrubs, which birds and animals also appreciate. Any improvement that increases human happiness is worth while, and the planting of trees and other plants that are both ornaments and sources of food for wild life is certainly one of such improvements. Lists of trees, shrubs, and vines that may be used for these purposes in various sections of the northern part of the country are given in the farmers' bulletins referred to on page 22.

Among the shrubs most valuable in producing food for wild life are the junipers, bayberries, spicebrush, sassafras, blackberries, dewberries, raspberries, roses, chokeberry, hawthorns, sumac, dogwoods, huckleberries, blueberries, elder, snowberries, blackhaws, and honeysuckles.

Among fur animals, the foxes and skunks eat a variety of berries, and it is probable that other species ordinarily not thought of as eating fruit may do so on occasion. To illustrate how generally certain foods are taken, it may be said that there are definite records of 118 varieties of birds eating raspberries; of 106 feeding on elderberries; 86 taking the fruits of dogwoods; 77 eating wild grapes; 93 eating sumac berries; 67 eating blueberries; and 33 feeding on hawthorns, or thorn apples; a catalog that could be extended in similar vein to great length. More detailed information on the preference of birds for various genera and species of food-producing plants is available in farmers' bulletins suitable for various regions and indicating the fruiting periods for various sections of the Northern States (see p. 22).

Of trees, any of the nut bearers, such as hickories, walnuts, butternuts, beeches, and oaks, are a boon to squirrels; maples, boxelders, tuliptrees, and ashes have winged seeds that squirrels, mice, and birds feed upon; and the fruit-bearing trees, such as the redcedar, hackberry, mulberry, hawthorns, flowering crabs, wild cherry, wild plum, holly, and tupelo, often known as sour gum, cater to a variety of wild life.

Pine mast is a good source of food for bobwhites, as well as for crossbills, grosbeaks, and other nongame birds; larches, pines, and other conifers also are attractive to these smaller seed eaters; and alders and birches produce seeds eagerly sought by siskins, redpolls, and goldfinches. Ruffed grouse use the buds of many hardwood trees, including the beech, aspen, maple, birch, alder, and hophornbeam, or ironwood. Cottontail and snowshoe rabbits eat young shoots and bark. In fact, rabbits sometimes damage orchards and nurseries, and care must be taken in such localities not to increase rabbits unduly or else to provide adequate protection for the trees. Directions for rabbit control are contained in Farmers' Bulletin 702, Cottontail Rabbits in Relation to Trees and Farm Crops. As already mentioned, rabbits can usually be thinned out if public hunting is permitted on infested areas.

ENCOURAGING VOLUNTEER GROWTH

The cooperative quail investigation worked out a number of methods applicable in the South whereby a volunteer growth of wild native game foods is obtained by stirring the soil at the proper season. Land plowed or disked late in summer, for instance, and left unseeded to crops, produced wild plants different from those in similar plots plowed in midwinter, and both of these types of vegetation differed from that in plots plowed in spring. The principle involved is that the soil is literally filled with thousands of seeds of many kinds, dropped in years gone by, but these seeds germinate only when influenced by the sun and other factors at precisely the proper time. The wrong time for one kind of seed may be just the right time for another.

Too little work has been done in the North to permit detailed recommendations for obtaining volunteer foods suitable for winter use, but it can be said that ragweed is one of the most extensively eaten and nutritious of game foods, being taken by quail, Hungarian partridges, prairie chickens, pheasants, and songbirds. It has the ability to stand up through snow and retain its seeds, and it readily volunteers on rich lands that are fall-plowed, especially on lands that have in the past been put to wheat and other small grains. Ragweed is probably the most abundant plant that follows the wheat harvest on many farms, often growing up from the cut stubble and maturing its seed before winter. Where winter feeding of game is desired in its simplest form on ragweed-producing soils, the leaving of a strip of wheat uncut will ordinarily result in a luxuriant development of tall ragweed plants that will withstand snow.

It should be pointed out that ragweed is the most troublesome of several scores of plants whose pollen induces hay fever, causing, according to the Public Health Service, 90 percent of the cases of autumn hay fever in the eastern United States. Control is thus desirable near human dwellings, especially near those containing people susceptible to this disease. In many places, however, ragweed may be utilized safely for food for wild life. The weed often makes its greatest growth after the planted crop has been harvested. Many present-day crops have originated from wild seed-producing varieties of plants, and ragweed may eventually be developed as one of the most important crops on lands managed for upland game-bird production.

The extensive grassy marshes so common in the Midwestern States, sometimes situated in great stretches of forest or, perhaps more frequently, occupying undrained depressions between agricultural lands, can also be improved for wild life. It is frequently noted that such grass or sedge marshes, although they afford much cover of a rather too uniform type and are occupied at certain times by pheasants and prairie chickens, especially, are remarkably barren of foods and thus do not constitute coverts that can be occupied the year round, at least by large populations of wild life. Where they are situated within practicable flying distance of weeds and grains, they may be used more or less constantly by game birds; but where these marshes are large and somewhat remote from agricultural lands, they are notable for the absence of such birds. It is probable that freeing some of the higher areas of these marshes from the sod, which prevents the growth of food-bearing plants, would permit increased production of food, and consequently make such places more livable for game birds. Some planting of grains and legumes in plowed areas also might well be made. Small grassy marshes do not require such treatment, but with tracts of large extent, the need for diversification and for an increased food supply becomes more apparent.

All the native legumes, or pod-producing plants, deserve consideration as foods for wild life, as their seeds are favorites with upland game birds. Not enough is yet known about certain varieties to justify recommending their use other than for experimental purposes, but partridge-peas, hogpeanuts, vetches, and soybeans are commonly found in quail stomachs. Among other plants, smartweeds, bristle grasses or foxtail grasses, and berries are known to volunteer after the ground is stirred, or in some cases, burned. Clover can be brought into almost any upland field or reasonably sunlit woods in the clover belt by stirring the soil and scattering seed, or by working in these areas with horses that are fed on clover hay containing good seed. The encouragement of clover is a practical step on tracts managed for upland game birds. Snowshoe rabbits, cottontails, and deer also are fond of it. Observations often will reveal other good food producers that will volunteer after the soil has been disked or dragged.

PROTECTING WILD LIFE

The kind and degree of protection it is desirable to extend to wild life on any farm necessarily depend largely upon the preferences of the landholder, but also upon the public interests, particularly as expressed in laws and regulations. Some owners will wish to afford equal protection to all wild life, an attitude that would let nature take its course. Many will want to exercise preferences among species by discouraging, for example, English sparrows, crows, or red squirrels, or encouraging the purple martin, the house wren, the gray squirrel, or other species. Others will desire to increase the bobwhite, the pheasant, the cottontail, and other game species. Preferential treatment of certain forms usually involves some degree of control of others, particularly predators. Protection of wild life on the farm, however, involves more than discouraging natural enemies.

Available information indicates that more than 50 percent of all upland game-bird nests on the ordinary American farm are destroyed by one agency or another. The most exhaustive figures on this subject are those obtained by the cooperative quail investigation in Georgia and Florida. Of a total of 602 nests studied, it was found that only about 1 out of every 3 was successful. Studies have been conducted, particularly in the North, of the destruction of the nests of other game birds, notably the ruffed grouse, the prairie chicken, and the Hungarian partridge, and in each case it was found that the destruction of nests was enormous. The same thing is experienced in England with pheasants and partridges, and a large increase of birds is obtained there by protecting every nest that can possibly be found.

The destruction of nests of song and insectivorous birds from all causes is even greater than that cited for upland game birds, often amounting to 70 percent or more. The losses among the young birds of both groups are also enormous, and there is, of course, some degree of mortality among the adults.

Less is known about the mortality among mammals, but it seems to be high. This is known to be true of rabbits. In general, mortality in wild life is greatest among the young, and it tends to increase in proportion to the number of young produced. In wild-life management the important thing is to increase the percentage of survival and to lengthen the average life span of individuals.

Listed in what is believed to be their approximate order of importance in the Northern States, the main agencies responsible for the usual destruction on farms of upland game birds (including eggs and young and adult birds) are: (1) Farming machinery and farming operations; (2) predatory wild animals; (3) domestic animals, including dogs and cats; (4) hunting; (5) climatic factors; (6) birds of prey; and (7) infectious and parasitic diseases.

No claim, of course, is made as to the accuracy of this listing other than in a very general way. Offhand it may seem that this is not the correct order of importance—that hunting is a much larger factor, or that predators are less important. Mortality is greatest, however, in the earlier stages of the birds' lives, and the chief causes in those stages are therefore the most important. Destruction of eggs alone accounts for 50 percent or more of the total mortality. If all agencies effective up to the fall season take half the young hatched from the remaining 50 percent of the eggs, it is evident that hunting and all other factors combined take their toll out of a population that is only one fourth or one fifth of the original number of eggs. This is not to say that hunting may not often be the largest factor in the destruction of the adult birds. The game manager, however, must consider percentages of hatch, nest survival, young survival, and all the other factors that determine a net increase or decrease in the fall population of adult birds. The larger factors of destruction

(1 to 3 above) operate more or less continually all the year, and the problem must be handled with this in mind.

It should be remembered, also, that the above discussion omits consideration of the most important factor of all in determining net increase or decrease (even though it may not cause direct mortality); namely, change in the physical environment. If the farm pond, which produces several broods of wild ducks as well as other aquatic birds, is drained, the resulting change in environment may cause a 100 percent decrease in the population of aquatic birds, so far as that farm is concerned. In fact, this very thing has happened on so many farms that it has resulted in a material decrease in the waterfowl resources of the Nation. The same thing has occurred, although perhaps less spectacularly, on much of the former prairie-chicken range, and the process, unfortunately, is still extending to other of our most valuable species of wild life. It is clear that though protection from machine, beast, and gun will accomplish something, attention must be paid to the fundamental conditions of environment.

DECREASING THE MORTALITY CAUSED BY FARMING OPERATIONS

The regularity with which farming operations destroy upland game-bird nests is not appreciated except by those who have systematically canvassed fields behind machinery. If harvesting is done early in the season, some of the birds dispossessed will make a second nest, particularly if incubation has just begun; later in the season, the nests destroyed may themselves represent second and probably final attempts of the birds to rear young.

Upland game birds, and field-nesting birds in general, often show a distinct preference for nesting in crops closely adjacent to fence rows or cover. This cover itself is a much used highway for enemies, and although many birds are raised every year in fence rows, it is probable that the fields are safer so far as natural enemies go. Hence, it is not uncommon to find nests comparatively concentrated in the several rods adjacent to fences, woods, marshes, and other good environments. Since so many nests will be found in growing crops, farm practice should be modified with this in mind, where game is regarded as a crop. For example, when harvesting grain and mowing hay in fields bordered by cover, the farmer can leave the close-to-cover part to the last. He can also safeguard many nests and give game an opportunity to get into cover without injury, by using a flushing bar like one of those shown in figure 14. Where seed is to be saved, it may be taken from selected parts of several fields instead of all from one; the additional time the seed hay is left in the fields, even if only a few days, frequently enables young birds to hatch and leave.

It is also possible in harvesting the smaller grain and seed crops, where straw is not of any particular use, to set the machinery so as to cut higher than usual, the object being to mow or cut above the nest, or to leave cover about it, so that the incubating bird will return if the eggs are not destroyed. The additional straw left on the field also has some fertilizing value. The use of header machinery on farms managed for game would be a practical step, as these machines leave almost all the straw standing in the field.

Much interest has recently been shown in various types of flushing bars that can be attached to mowers or reapers to flush ground-nesting birds before the cutting blade destroys them or the cover for their nests. If the machine is halted and the sickle lifted after the bird flushes, so as to leave an " island " of cover over and around the nest, the chances are this will not be deserted.

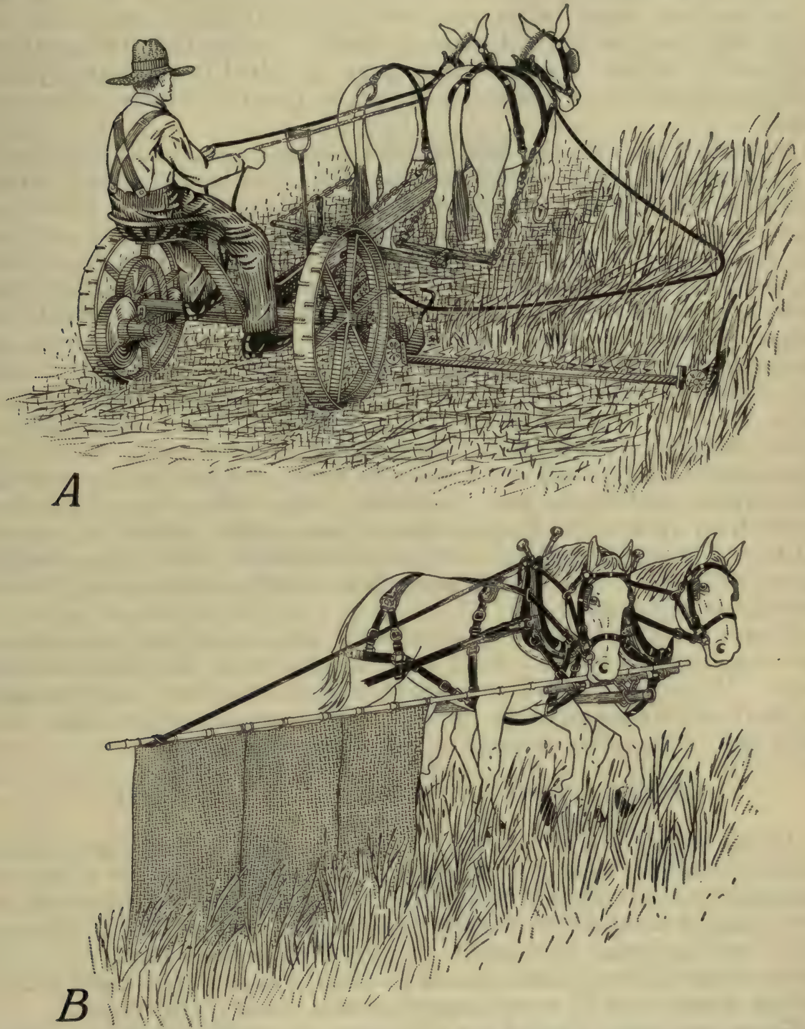

FIGURE 14.—Flushing bars: *A*, The Gopher Camp Fire Club flushing bar; *B*, the Iowa flushing bar. (Courtesy of the American Game Association.)

Two types of flushing bar are shown in figure 14. The Gopher Camp Fire Club flushing bar (fig. 14 *A*) is made of 5/16-inch soft iron, one end looped and the other welded to a 2 by 6 inch plate in which two ⅜-inch holes are drilled. The drilled end of the bar is bolted to the tongue near the mower, and the looped end is fastened to the hames. A simpler device, the Iowa flushing bar (fig. 14 *B*), consists of a bamboo pole extending out from the neck yoke and supporting burlap sacks that are slightly weighted—with links from old tire chains, for example. The outer end of this bar is supported by a strap attached to the hames.

In years of large crops and low prices strips of uncut hay or grain can well be left adjacent to cover. Later livestock grazing will put it to good use; or where game is a real consideration, it is well worth while to leave the strips to provide winter cover and food.

In connection with the destruction of nests by machinery it should be remembered that machines are often needlessly driven across pieces of waste land, over fence rows, and through fallow fields and other such places. Short detours to avoid these areas may prevent the destruction of some hidden nests. If game increase is the important object, machinery should not be used on certain favorite nesting grounds at all. Hand harvesting of corners that are almost certain to harbor ground-nesting birds is worth while, although on the general farm these and other practices with the same end in view may not be feasible. They are important and practicable considerations, however, where wild farming of game is being undertaken.

On European game preserves keepers systematically search the fields ahead of farming machinery to avoid destroying the nests of Hungarian partridges and pheasants. The method is of greatest value when prior observations have been made. When a pair of birds or a female bird has been observed in the same place several times, or there is other indication that a nest may be near, special search for it is made.

Sheep, hogs, and cattle trample many nests, and it is well, therefore, to keep livestock out of some of the more favorable nesting cover. Where grazing of such cover is to be done, it is good practice to start it well in advance of the nesting season rather than turn stock into cover after nesting is well along.

BIRDS OF PREY IN RELATION TO WILD LIFE

There are so many kinds of hawks and owls, and their habits differ so widely, that it is impossible to classify them as a definite economic group. No wholesale destruction of hawks and owls, however, should be tolerated. Such destruction is not wild-life management, but ignorant or willful disregard of facts. There has been much misguided emphasis placed by people who should know better, on the destruction of everything that occasionally kills birds.

Game managers should get the facts concerning each particular area that is under control. Practically all predatory-game relationships must be determined as local problems—instead of county, State, or national—and the degree of control must be adjusted to local needs. Local conditions often prove markedly different when carefully studied, although to casual observation they may appear similar.

Every hawk and owl, except individuals actually seen destroying poultry or species that are consistently destructive, should have the benefit of intelligent consideration before its guilt or innocence is decided. Owls have the habit of rolling all the coarser indigestible portions of their meals into compact balls, or pellets, and regurgitating them. Examining these dry rolls of bone and fur or feather is not at all offensive, and they afford a dependable check on the food habits of owls. Care must be taken, however, to identify correctly the owl that ejected them, if the observations are to have value as a guide to control policies in game management. Observation of the hawks and examination of their nests will show whether the birds are doing more good than harm.

The pellets of hawks are not so easily found nor so easily studied as those of owls. For judgment on hawks, it is necessary to consider the published results of general studies of stomach contents and to check these with impartial local observation, deciding the matter upon this basis. Hawks of nearly any species may at times prey upon song or game birds, but the vast majority exert a distinctly beneficial effect on game by controlling food competitors; by eliminating diseased and unfit individuals, which menace the good health of their fellows; and by keeping wild creatures alert and in sporting condition. Hawks and owls and other predators are probably necessary to top-notch fitness and alertness of game. Few sportsmen have any desire to shoot half-tame birds that have been reared in an environment where safety is always assured.

By and large, it is cheaper, easier, and better to improve the emergency game and songbird coverts on the farm than to undertake extensive control of winged predators, even where the need exists, except in the case of the great horned owl, and of the sharp-shinned and Cooper's hawks. When control is undertaken influx of predacious birds from other areas soon fills the vacancies. The yearly toll taken by predators on many game farms is almost constant, indicating that no real progress has been made even where wholesale control is attempted. It is impossible to control predacious forms on an effective scale, on most farms, by individual effort.

If control of these birds is necessary, directions for carrying out preventive and (in extreme cases) aggressive measures may be obtained in Leaflet 96, Protecting Poultry from Predacious Birds.

OWLS

When owls are present on a farm their roosts are not hard to find. In these, the owls often sit day after day, disgorging from time to time their pellets (fig. 15) of fur and bones. Literally bushels of mice are consumed by small owls, and these birds may well be called self-setting mousetraps; practically every night, and sometimes several times a night, their talons snap shut on mice. They should certainly have a chance to live. The screech owl (fig. 16) and the long-eared, short-eared, barred, barn, and saw-whet owls are all particularly valuable as rodent destroyers.

Great horned owls (fig. 17), however, are sometimes destructive to game, although at other times they eat many rats and pocket gophers. When they locate a chicken yard, they are likely to return to it night after night. This habit is almost confined to this one very large, ear-tufted species. Smaller owls should not be confused with these big fellows. Great horned owls, where really abundant, can be a decisive factor in determining the rate of increase of game, especially of rabbits. Whether this owl should be drastically reduced in numbers will depend upon the primary object of management. If rabbits are an object, this owl, if at all numerous, must be controlled. In an orchard community, however, the great horned owl may be a blessing. It is a question for local determination. Where the presence of wild life in general is desired, the great horned owl may have partial protection, for there are few more picturesque or interesting birds. Under all ordinary circumstances owls of other species should

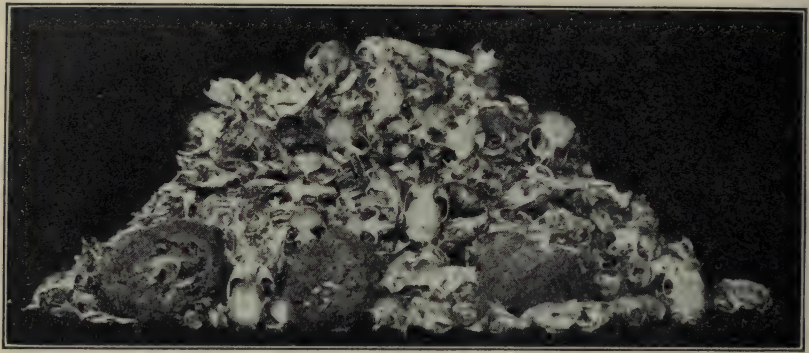
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FIGURE 15.—Field-mouse skulls taken from barn-owl pellets. The slaughter of birds doing this type of work is far from conservation.

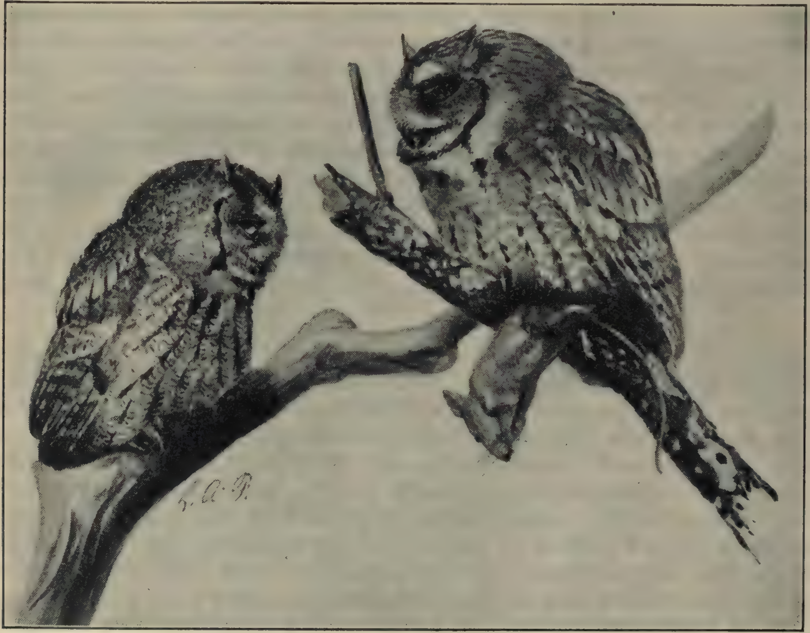

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FIGURE 16.—Screech owls. These birds can well be called self-setting mousetraps.

be left strictly unmolested. Much of the nest thievery so frequently blamed upon the smaller owls is the work of cats.

Effective control of great horned owls, where investigation indicates that it is warranted, includes the location of nests and the destruction of both adults and young. The owl ordinarily places its nest on an old crow nest, on a stub, or in a hollow tree before the snow has disappeared and while the trees are bare. In any case, large fluffy bits of owl down are usually to be found on twigs and branches for several rods about the nest site, and the presence of such down about the nest itself indicates its occupancy. Care should be taken not to confuse great horned owls with other owls of more beneficial habits. The practice of shooting into nests is vicious and destructive to many innocent creatures.

Nest hunting in March, together with the following up of late spring mobs of crows and jays, whose clamor often indicates the finding of an owl (care being taken in identifying the species) is effective; it reduces only the resident great horned owls, and is far preferable to the use of steel traps.

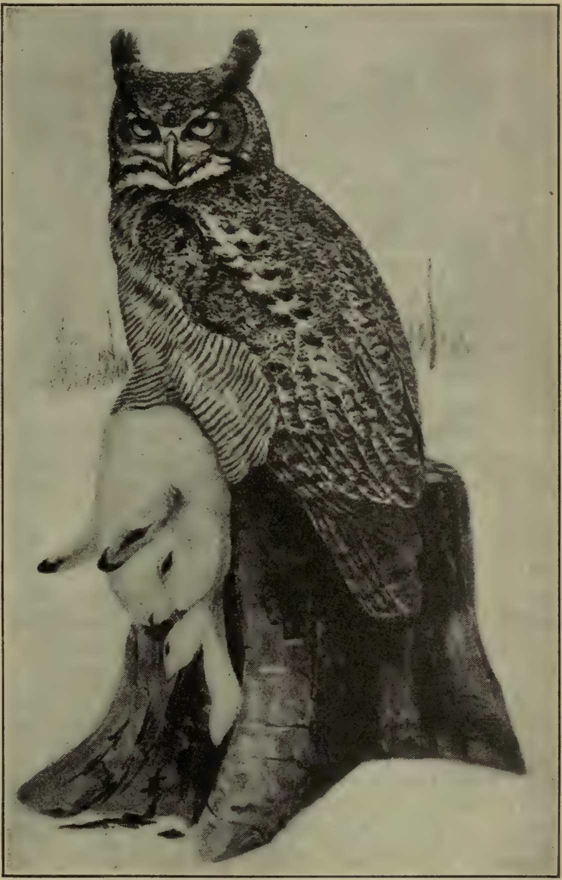

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FIGURE 17.—Great horned owl. A powerful species, often destructive to game.

If it is necessary to use steel traps for great horned owls, it should be done only in the winter months, when there is a minimum population of small birds that might be caught. To safeguard all innocent creatures the traps should be set late in the afternoon and unset early in the morning so as to limit their danger mostly to the hours of darkness. The killing of smaller birds can be obviated, in part, by setting the traps so that the lighter birds will not spring them. This can be done by regulating the depth in the notch to which the trigger of the trap is adjusted or by putting under the trap pan a twig, a special pan spring, a light coil spring, or a pad of cotton that will give under the weight of the large bird but not under that of smaller ones. (See also Leaflet 96, Protecting Poultry from Predacious Birds.)

The use of the indiscriminate pole trap should be earnestly discouraged. Pole traps kill songbirds and injure many useful birds of prey, and they frequently fail to catch the destructive types of hawks, which often alight in the woods instead of in fields, and in trees rather than on poles.

HAWKS

COOPER'S AND SHARP-SHINNED HAWKS

Cooper's and sharp-shinned hawks are so destructive to poultry and wild birds that it may be necessary to kill all individuals of these two species that can be found in the locality. Even so, control will rarely be fully effective, as these are the most elusive of hawks, but it can materially reduce their depredations. Practically all poultry and game-bird destruction can usually be traced to these short-winged and long-tailed, woods-loving, blue or brown "darters". They are rather small hawks (fig. 18, *5* and *6*), being about the size of a pigeon, or smaller, but with more slender proportions and with longer tails. They do not commonly soar, but rather skim closely over cover and dart upon and seize their usually feathered prey in a most audacious way. They suggest the small scouting airplanes, and do not closely resemble the large, blimplike buzzard hawks, which soar high in the sky (fig. 18, *8–13*) or sit conspicuously upon high perches. Cooper's and sharp-shinned hawks ordinarily are scarce in farmed country, as they prefer large wood lots, or even forest. The larger goshawk (fig. 18, *7*), also of the darter group, which occasionally invades the northern United States during the winter months, preys extensively on game birds, especially on the ruffed grouse. It is of such infrequent occurrence, however, and so confined to woodlands, that it will rarely be encountered on farms.

MARSH HAWK

The marsh hawk (fig. 18, *4*) should not be confused with the Cooper's and sharp-shinned hawks. Though much larger, it has somewhat the same proportions as the blue darters and also seldom soars, but both the wings and the tail are noticeably longer. It differs in coloration with sex and age, but can be recognized in any plumage by the conspicuous white patch at the base of the tail. This identification mark is easily seen while the graceful hawk beats slowly over meadows and fields, a few feet above the vegetation, in search of small rodents and birds. It preys upon meadow mice, pocket gophers, and ground squirrels, and upon some of the smaller marsh birds; but ordinarily it has no long-time detrimental effect upon game birds. As a rule, it should be protected.

SOARING HAWKS

The large soaring hawks have broader wings and tails than do the darters and the marsh hawk, and are slower in all their movements. With the exception of persistently destructive individuals,

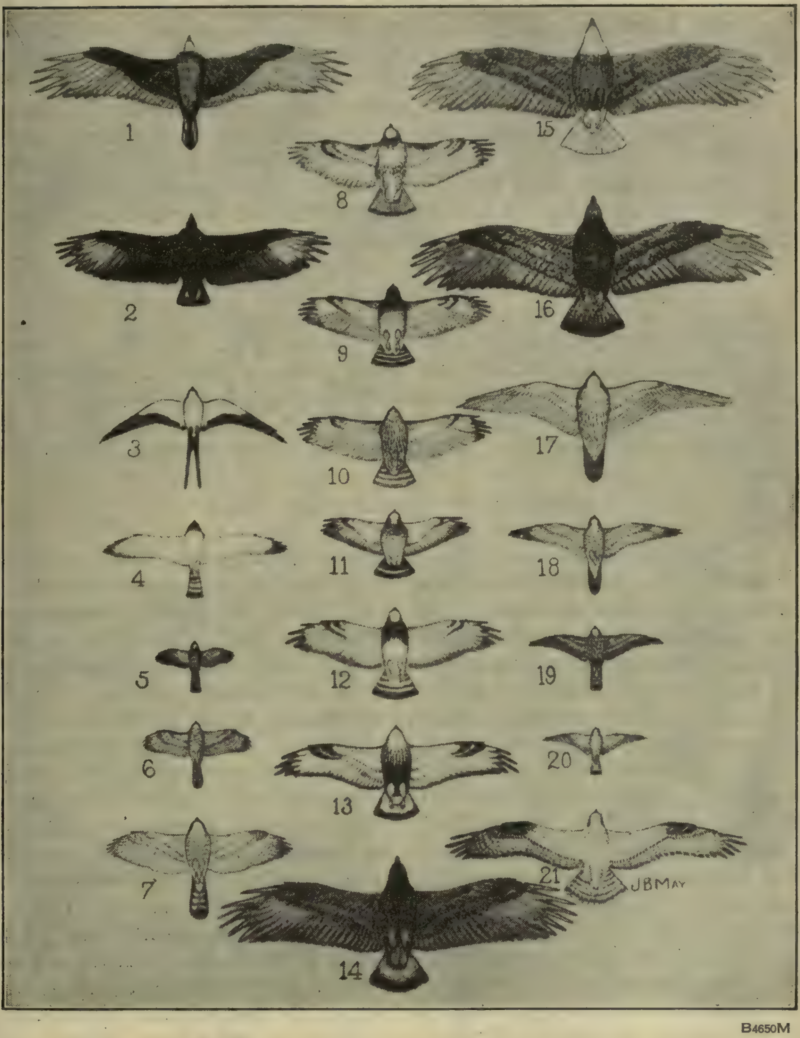

Figure 18.—Common predacious birds, as seen from below in flight. The field identification marks have been accentuated to facilitate recognition.

1. Turkey vulture.
2. Black vulture.
3. Swallow-tailed kite.
4. Marsh hawk (adult male).
Sharp-shinned hawk (small immature male).
6. Cooper's hawk (small adult male).
7. Goshawk (adult).
8. Red-tailed hawk (adult).
9. Red-shouldered hawk (adult).
10. Red-shouldered hawk (immature).
11. Broad-winged hawk (adult).
12. Swainson's hawk (adult).
13. Rough-legged hawk (immature light phase).
14. Golden eagle (immature).
15. Bald eagle (adult).
16. Bald eagle (immature).
17. White gyrfalcon.
18. Duck hawk (adult).
19. Pigeon hawk.
20. Sparrow hawk (male).
21. Osprey.

(From drawing by John B. May, reproduced by permission, from Birds of Massachusetts and Other New England States.)

they should be left in peace, as they feed chiefly upon mice and other rodents, and to a lesser extent upon insects, snakes, and frogs. The most common of the soaring hawks is the red-tailed (fig. 18, *8*), often seen wheeling in circles high in the blue, above agricultural regions with wood lots or wooded river valleys. The red-shouldered hawk (fig. 18, *9*) is also found in such places, but particularly in the denser woodlands. Both these hawks seem comparatively clumsy and glean their living from less agile creatures than upland game birds. Occasionally they are successful in picking up a cottontail or in catching a squirrel far from cover. The soaring hawks may safely be left unmolested in most agricultural communities, except for the occasional individuals that acquire destructive habits.

OTHER HAWKS

The little reddish-brown sparrow hawk (fig. 18, *20*), a round-headed falcon often seen perched upon poles, where its characteristic tail-flirting movement is prominently displayed, has almost wholly beneficial habits. This is also true of the broad-winged (fig. 18, *11*), the rough-legged (fig. 18, *13*), and other comparatively rare hawks.

CONTROL OF PREDACIOUS BIRDS

The great horned owl, the Cooper's hawk, the sharp-shinned hawk, and the goshawk are the only species of predacious birds whose destruction is ordinarily warranted on game-management areas. Other hawks and owls eat enormous quantities of mice, rats, snakes, pocket gophers, and ground squirrels, and thus reduce the food competition faced by game species in critical periods. Predatory birds are of sufficient worth to justify their protection, both because of their beauty and of their influence in keeping game alert. Though the occasional individuals of almost any species of predacious bird that become destructive may be eliminated (for directions see Leaflet 96, Protecting Poultry from Predacious Birds), it might be well to concede to even hawks and owls a reasonable "bag limit" of game in return for their destruction of rodents and other pests. The hawk that eats several hundred mice, which otherwise would consume a great quantity of winter game-bird food, may even be said to have contributed more toward the welfare of the game than has many a sportsman, content to purchase a license and to destroy without in any way balancing his destruction by exerting any favorable or constructive environmental influence. Game may be given a large measure of protection against predatory forms, if adequate emergency coverts are provided, incorporating thorny tangles of dense vegetation with openings at the base.

Wholesale destruction of hawks and owls by side hunts or "vermin-killing" contests is never warranted. Groups contemplating organized destruction of predacious birds are urged to direct the same energy toward the development of adequate coverts; but if determined to conduct such campaigns, they are requested to make arrangements with the Bureau of Biological Survey for the preservation and analysis of all stomachs of the birds killed (and identified), in order that a scientific appraisal of the situation may be made. Neglecting to utilize such opportunities for increasing the stock of real knowledge of predators shows prejudice of a sort that is likely to defeat progress in wild-life management. Destruction of any form of wild life without due consideration of pertinent facts may be highly detrimental to game management.

CATS AND DOGS AS GAME DESTROYERS

In well-settled communities the house cat is probably the greatest single agency of game-bird and songbird destruction. Cats have been observed to eat eggs just prior to hatching, locating the nests by the calls of young birds yet in the shells. It is well known that a cat will capture young songbirds in their nests, often just when they are ready to take flight. Cats also eat young rabbits and kill incubating quail, partridges, and prairie chickens on their nests. Cats will even kill more than they consume, playing with many birds they do not eat.

For some of these things the house cat may be forgiven on the ground that cats must live according to their instincts and because they are valued as pets and render some service in destroying mice and other rodents. The number of cats must be kept down, however, if wild-game farming is to succeed, and the farmer who wishes to increase the abundance of game and song birds will see to it that certain common practices relating to cats are not allowed on his farm.

The first is the keeping of more cats than are needed. Some farms have 8 or 10 cats, when 1 or 2 would do just as well. The numerous cats frequently wander all over the countryside, taking up residence for a time on one spot, and then moving elsewhere. Stray cats are a menace to wild life and, if the law permits, should be shot on sight.

Another practice, that of allowing cats entire freedom at night and early in the morning, enables them to hunt at the time they can be most destructive. Every farm cat should be locked in a granary, storeroom, or other place where it can do some good, or at least no harm, at night and in the early morning, instead of being permitted to roam the fields. Most farmers are unaware of the wide excursions made by their cats, often thinking the cats are fast asleep in the haymow or granary when in reality they are on the prowl, ravaging communities of songbirds and disrupting coveys of game birds. Directions for trapping stray cats are published in Leaflet 50, How to Make a Cat Trap.

There is a habit among some unthinking townspeople of taking unwanted cats into the country in sacks and dumping them near farmyards. Such persons can usually be apprehended under State or municipal humane laws for wanton neglect of dumb animals. The practice is vicious in its effects upon wild life, as it often forces cats to make their living off the country. It will bear repeating that any stray cat should be killed.

Dogs, also, do some damage to game but are less able than cats to kill any but young birds. Dogs should be kept out of game coverts during the nesting period; at other times they should not be allowed to range in the coverts, except under supervision for training or for hunting purposes. Dogs are relatively harmless, however, as compared with cats, and although they may chase game, they seldom capture it. Furthermore, most dogs are duly licensed and carefully taken care of by owners.

PREDATORY WILD ANIMALS ON GAME-MANAGEMENT AREAS

Ordinarily on farms the problem presented by fur animals, which prey more or less on other forms of wild life, solves itself where there are energetic boys. The bulk of America's skunk pelts, for instance, in normal times worth several millions of dollars yearly, are taken by farm boys. These pelts are an asset on most farms, and consequently the animals should themselves be managed for a sustained yield. Furthermore, it is well known that many fur animals feed upon mice, ground squirrels, and insects, so that from that point of view, also, they may be regarded as economically beneficial and should be maintained in reasonable numbers.

Some difficulty is experienced, however, on refuges, where no trapping is permitted. Under such circumstances, predatory animals and fur bearers may increase unduly and defeat any preferential treatment desired for game. Reasonable trapping is sometimes necessary in game management. In the cooperative quail investigation a decided reduction in nest mortality and a consequent increase of quail were obtained by trapping skunks and other fur animals on preserves previously closed to all trapping.

In regions where farm-game management may be interfered with by the presence of coyotes or other predatory wild animals, measures should be taken to bring the predators under control. Recommendations as to methods may be obtained from the Bureau of Biological Survey.

The object of wild-life management, in general, should be to bring about an increase of all forms of desirable wild life, including fur animals, rather than to exterminate one group for the supposed benefit of another. It is not desirable to have a farm either overpopulated with fur animals or barren of them. With proper abundance and distribution of cover, and with an ample food supply, it should be possible to obtain a simultaneous increase not only of game, but of most hawks and owls, of a majority of the small fur bearers, and of practically all songbirds normally found on the land. In fact, many hunters and farmers recall finding a great abundance of song, game, and insectivorous birds as well as of fur animals and predacious birds in some favored locality at the same time. This demonstrates again the importance of coverts. Some predatory-animal control fails to increase game because no corresponding improvement of coverts is attempted.

A combined crop of fur and game can be harvested on a great many farms where one alone would not be particularly profitable. As byproducts of the American farm, each deserves careful consideration. Many farms are producing excellent fur crops. On others the environments necessary for fur animals have been destroyed or the seed stock has been trapped out. Due attention to these factors is necessary.

In all cases, both farmer and game manager should be familiar with the predatory-animal population on the managed area, and any time that an undue increase of fur bearers is indicated, plans should be made for relieving the situation. The aim should be to trap fur animals during the prime-pelt season, allowing them almost complete protection at other times, except when they threaten definite destruction. It should be borne in mind that most of them are protected by law except during a specified open season.

Fur and game farming offer possibilities to farm boys, who will be interested in publications of the United States Department of Agriculture on these subjects, lists of which will be furnished on request addressed to the Bureau of Biological Survey.

INFECTIOUS AND PARASITIC DISEASES

Diseases, including those caused by parasites, sometimes play an important part in reducing the ranks of certain birds and animals. For some no control measures have as yet been devised; others may be partially held in check. Usually, the devastating spread of most diseases implies a dense population of birds or animals. In other words, if there is one game bird for every 40 acres, the chance for quick transmission of parasitic and other diseases is relatively slight; if on the same area there are two birds to the acre, the chances are increased by the more frequent close contacts of individuals. It is theoretically possible, therefore, to have too many birds or animals on a given area at one time. In fact, this is exactly the difficulty experienced on game farms and game-propagation plants at certain times. It has even been suggested as a reason for the sudden " die-offs " of ruffed grouse and snowshoe rabbits under natural conditions in the North.

Overpopulation is undesirable also from other points of view, and reasonable hunting may actually be necessitated as a disease-control measure. Certain it is that any animal species can become too numerous for its own welfare; the approach of this condition calls for hunting or some other form of elimination.

Preventing disease and the spread of parasites is to some extent feasible on farms, as some diseases and some parasites are transmissible from poultry to game birds, and even vice versa. For this reason, on game-management areas poultry should not be allowed free range. Turkeys and chickens, especially, should not range through game coverts. Poultry manure should not be spread over the fields promiscuously, unless the ground is to be plowed immediately. The bodies of dead birds should be burned or buried, not thrown on the manure heap for later distribution to fields and game ranges.

Diseases and parasites do not ordinarily destroy much farm game if other eliminative processes are allowed to take their course. Usually, in the wild state, it is not necessary to be particularly concerned about disease. The aim should be to promote the general good health of birds and animals by making plentiful food and coverts available and by encouraging all factors that keep wild things alert and healthy.

Should diseased birds or animals be encountered, however, the condition may be described to the Bureau of Biological Survey, Washington, D.C., and if further investigation is needed, this organization will furnish instructions for preserving and shipping specimens.

REGULATING HUNTING ON GAME-MANAGEMENT AREAS

It is needless to state that illegal hunting must be stopped on game-management areas and legal hunting adjusted to the game supply; that is, in areas where the legal bags permitted are larger than the supply justifies, hunting should be kept within reasonable limits. There are occasionally cases in which the available game supply might warrant a much larger bag and a much longer season, and these will become increasingly numerous under a widely practiced system of game management. To this end legislation should take into account the farmer's efforts in behalf of game. Flexible administration of seasons and bag limits, based on the actual supply and on the degree to which coverts and food resources have been developed, should be sought, rather than inflexible legislation.

Several Northern States have suffered severe diminution of their quail stocks, even with open seasons of but a few days and with restricted bag limits, whereas in several Southern States a very decided increase in the numbers of quail found on heavily hunted preserves has accompanied liberal bag limits and seasons 3 and 4 months long. The difference between these two extremes lies in intelligent game management. Legislation should be so framed as to furnish an incentive to practice game management. On two properties, side by side, one owner may provide food, increase coverts, afford protection from the worst enemies, and obtain an increase of birds, while at the same time his neighbor, by cultivating every foot of his property, exterminates game. Legislation that grants these two men equal privileges as to taking game does not encourage further planned management for the increase of game.

One State has already initiated what is known as the differential seasons system, and provides a longer season for lands on which propagated pheasants are released. The principle is entirely sound and might well be extended to all species that respond to management, rather than restricted to those that can be reared by hand. The total kill should always bear a reasonable relation to the population, however. Under the British system, for instance, the number of game animals that may be taken from an area is definitely limited in advance.

Hunting problems are too often considered as country-wide or statewide when they may really be only farm-wide. It is unwise to enact laws permitting the killing of game on all lands within a large political division regardless of the fact that on many farms within that area there is little or no game. Equally unwise is it to close entire counties or States to hunting when it is obvious that certain farms have abundant supplies of game that are well taken care of by the landowners. Without game management, it may be too much to allow the killing of 1 percent of the birds. Under intelligent management, it may be possible to kill 50 percent of the adult game without detriment to the permanent stock.

Certain kinds of game endure a much heavier rate of kill than others. Cottontail rabbits, for example, stand heavier hunting than will prairie chickens. The degree of hunting that a specific farm can safely afford must be worked out on the basis of local information. To this end, it is important for each farmer to make a game survey of his farm-game resources, to keep accurate records of all hunting done there, and to note down the kills resulting. Only by means of accurate year-to-year comparisons can the game crop be harvested on an intelligent basis.

HOW TO MAKE A FARM-GAME SURVEY

This bulletin has thus far discussed some of the broader relationships of farm environment to wild life. Each farmer or game manager must himself appraise the conditions on his own premises. Not only should he know the situation as to numbers and kinds of birds and animals at the start but it is necessary that he keep records of either stable or changing conditions over a considerable period of time. Chance circumstances may favor an excellent crop of birds one year, but less fortunate conditions may greatly reduce the supply the next. It is most desirable, therefore, for each game manager to institute and maintain a farm-game survey. This survey should be continuous, or repeated at intervals of a few months, and should take into account all those factors that operate for or against wild life on the farm and are subject to control. Since food and cover are fundamental and lend themselves to management, the farm-game inventory should give them particular attention.

MAKING A MAP OF THE FARM

To aid in the farm-game survey, it is desirable to have at least a rough map of the farm. This should show locations of creeks, buildings, woods, fences, and other common features, in addition to fields in crops. It is well to prepare a new map each year in order that the effect of continued or modified practices may be apparent. The work of mapping is really fascinating and will bring out interesting details of bird and animal localization that are not at first obvious. The wild life found on the farm can be shown on the map with surprising accuracy. The map need not be elaborate. An ordinary sheet of paper will be sufficient for each 10 to 40 acres, or other definite unit. Sketch maps of a farm, before and after alterations were made in favor of wild life, are presented in figures 19 and 20, illustrating a simple but useful type of map.

ENUMERATING AND PLOTTING THE GAME

With the map as a basis, and each square designated by a number, a list may be made of all the varieties of birds and animals found on the farm, and on each of its subdivisions, or of those that have some particular interest. An estimate can be made as to numbers by using sight records, or by taking tracks, dust baths, calls, nests, or other signs as the basis after some unit of measurement has been approximated. In table 3, a sample blank for a wild-life inventory chart, the first column is used for the species; the second for its estimated numbers; the third for its location, using the number of the square on the map; and the last column for an entry showing whether, in the opinion of the enumerator, a particular species is stationary, increasing, or decreasing. The situation having been appraised in this way, reference to the map and to the list of farm practices in relation to game (pp. 42–44) should be made to determine, if possible, the main factors that limit the further increase of the species. Often there will be found significant differences in the wild-life productivity of various portions of the farm, and these differences should be examined for possible correlation with causative factors.

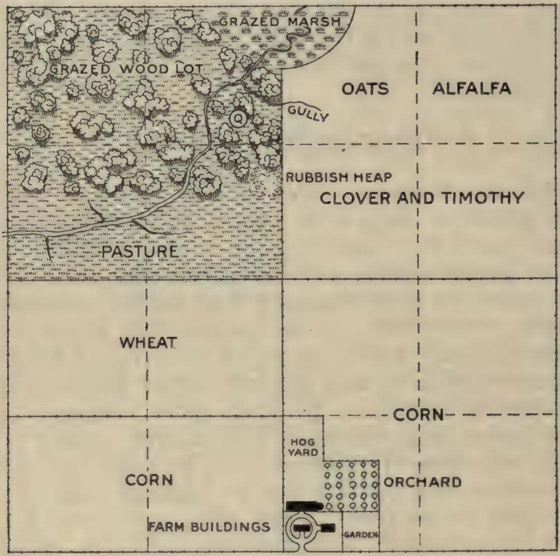

Figure 19.—Map of a 160-acre Corn Belt farm before it was improved for wild life. (See also figure 20.) Hogs use orchard in foreground; no trees on lawn about farm buildings; only one covey of quail (Q in circle) on farm.

Table 3.—*Sample blank for wild-life inventory chart*

Species	Estimated numbers	Map square [1]	Status [2]	Species	Estimated numbers	Map square [1]	Status [2]
Birds:				Birds—Continued.			
Bobwhite quail				--------			
Prairie chicken				--------			
Ruffed grouse				Mammals:			
Hungarian partridge				Cottontail rabbit			
Ring-necked pheasant				Snowshoe rabbit			
Woodcock				Squirrels			
Jacksnipe				Raccoon			
Wild ducks				Opossum			
Crow				Skunk			
Great horned owl				Mink			
Small owls				Weasel			
Cooper's hawk				Red fox			
Soaring hawks				Gray fox			
Marsh hawk				Wild house cat			
Sparrow hawk				Muskrat			
Woodpeckers				Coyote			
Orioles				Pocket gopher			
Robin				Mice			
Bluebird				Rats			
Brown thrasher				Woodchuck			
Mourning dove				--------			
House wren				--------			
--------				--------			

[1] Indicate by number; see figs. 19 and 20.

[2] Stationary, increasing, or decreasing.

CHECKING UP ON COVER AND OTHER FACTORS

After showing on the map the areas of cover and food, it is well to make a summary of the findings, to facilitate consideration of improvement methods. As a start in checking up the cover resources of the farm in a definite way the following schedule may be used as a guide:

SCHEDULE FOR SUMMARIZING RESULTS OF FARM-GAME SURVEY

Indicate for each of the following coverts on the farm the approximate acreage (or length) and the grazing condition (the condition of these areas with respect to grazing may have a great effect upon their value as wild-life cover):

Grassy marsh or swamp
Wooded swamp
Wood lot
Orchard
Vineyard
Berry patches
Garden
Fallow fields
Pond or lake
Windbreaks
Grassy fence rows
Brushy hedgerows
Creeks and rivers
Eroded gullies
Very rocky land
Hilly land
Isolated land
Unproductive soil

State which of the above types can best be put to the growing of trees, game, and fur, instead of continuing under present use.

State which can be profitably extended.

Note where windbreaks would be of assistance in checking erosion, preventing lodging, and conserving moisture.

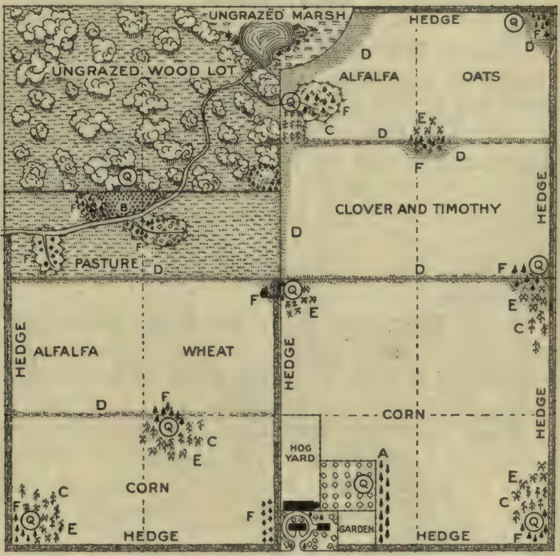

FIGURE 20.—Map of farm shown in figure 19, after it had been improved for wild life. Woods and marsh fenced and ungrazed; pond constructed in marsh; rubbish heap surrounded by trees; gullies planted; orchard protected from hogs; trees planted on lawn; wheat acreage decreased and alfalfa acreage increased to offset woods formerly grazed: A, Windbreak round buildings; B, millet patch; C, standing corn feed patch; D, hay strip left standing; E, shocks of corn left in field; F, cover patches—low spruces, large thorny roses, grapevines, sumac, hay. Numerous quail covies now on farm.

Indicate quantity of standing or shocked corn available for game. Is it well located in relation to cover?

State which of the following foods are found in abundance and which should be increased:

Wild grape
Virginia creeper
Bittersweet
Elderberry
Dogwood
Wild cherries
Wild raspberries
Ragweed
Amaranth
Lambsquarters
Others

List the most serious enemies of wild life on the premises.

Check up on the number of cats, especially strays. Are there too many? Are they confined at night?

List the species of game killed during the last open season and the numbers of each. (This item should be given careful consideration. All hunters should be required to report game bagged on the premises, and a written record should be kept by days, by number of hunters, and by seasons.)

List the species of fur animals trapped on the farm and the numbers of each. (Records similar to those of the game animals should be kept for the fur bearers.)

Other methods of determining the present game-carrying capacity of the farm and what to do to increase this capacity will suggest themselves and should be recorded in the summary. Consideration of the various farm practices discussed elsewhere (pp. 42–44) may suggest a convenient method of further checking up on the wild-life situation.

POSSIBLE RETURNS FROM GAME MANAGEMENT

Usually it is necessary to consider the purely economic aspects of proposed activities in game management, particularly where these involve a choice of one land use or another. Regardless of the actual or potential use of the land, taxes and upkeep go on. For this reason, farmers will be interested in learning how improvements made in the interest of wild life are paying their way. Methods of payment to farmers are discussed on pages 59 and 60, but the following instances give concrete evidence that game, though new as a farm crop deliberately encouraged, has worth-while possibilities as a source of income:

In the aggregate there are large areas, particularly in the Southeast, where lands are now leased primarily for the shooting rights, customary rentals running from 10 to 15 cents per acre.

An association cooperating with a group of ranchers in California paid the ranchers for use of horses, riders, camping outfits, supplies, board, and lodging. The association charged daily fees, ranging from $1 to $2.50 and amounting in one season to $3,060, and used its funds for restocking, for supplemental feeding, and for control of natural enemies.

In Texas landowners must be licensed to sell shooting rights, and the fee is limited to a maximum of $4 per day, or to 25 cents per acre under leases.

A similar plan is in effect in North Carolina with organizations controlling 3,000 acres or more.

In Iowa 7 farmers with approximately 4,000 acres of land recently established a game-management area in cooperation with a chapter of the Izaak Walton League. During the 1932 shooting season, when hunters were charged 50 cents for each bird shot, one farmer received $24.50, another $10.50, and a third $3.50. The others had allowed friends to shoot without paying or had had no game taken.

In Ohio 28 farmers on an area of 11,000 acres under central management have charged $2.50 for hunting permits for the area. During the fall of 1931, under this system 200 hunting permits were issued, bringing a revenue of $500.

In Michigan farmers joining "hunting exchanges" are aided in control of trespass, and hunting tickets, limited in number, can be obtained only at farmhouses. Licenses for shooting preserves also are issued, requiring the propagation and release of 100 or more game birds and providing for the sale of hunting rights.

Wisconsin has a law similar to that of Michigan.

In Nebraska coupons sold by the State game commission may be paid out for hunting privileges to farmers registered with the commission. These coupons, of a value of 50 cents for each pheasant, are redeemable by the commission or, in actual practice, by banks or business men locally.

THE FARMER'S PART

In considering the possibilities of returns from game management three things are to be borne in mind: (1) Any sound system must preserve adequate seed stock for the next breeding season, with a margin sufficient to absorb both winter and hunting losses; (2) it must so limit the kind and the extent of hunting as not to drive all the game out of the managed area; and (3) it must reduce all abuses to the minimum.

The whole object of sport is recreation, and to this end hunting should be made difficult. It is neither true sportsmanship nor recreation to shoot birds that have no escape from sure death before the most modern of firearms and with few or no factors in their favor. The aim in developing areas for sport should be to arrange coverts to the advantage of the game and thus make hunting so difficult as to demand skill and effort on the part of the sportsman. The most enjoyable hunting is in localities where game is abundant enough to afford many glimpses of it, but where it is difficult to obtain a reasonable day's bag, because the odds favor the game and not because game is scarce. Frequent and well-placed coverts are the best means to this end.

In providing accommodations for hunters each season, farmers will do well to give preference to those who are more interested in sport than in bag limits. Not only should farmers see that the legal limits are enforced, but where these are too large for local conditions on his farm, he should prescribe a lower farm limit. To reduce waste of game, it is well to have available one or more good retriever dogs.

METHODS OF PAYMENT

EXCHANGE OF SERVICES BETWEEN SPORTSMEN AND FARMERS

The exchange of services between sportsmen and farmers usually is arranged in such manner that neither of the parties receives actual financial profit, but each enjoys benefits. In return for privileges granted him the sportsman frequently supplies stocks of birds not previously found on the premises, often furnishing these at considerable expense; or he may provide planting material for cover and food purposes on poorer lands; or pay the taxes on better lands that can be managed for game but otherwise would be utilized for the more usual cash crops. The farmer enjoys an increased game supply for his own use and is relieved of the burden he formerly assumed of paying taxes on unproductive lands.

This kind of relationship is worthy of wide employment. It has, in fact, been entered into on a large scale in Michigan. The exchange-of-service system is sound in that both parties to the bargain have a definite incentive to preserve and increase the game supply. Such efforts result also in a great increase of fur animals and other forms of valuable wild life that make use of game coverts.

RENTALS

Leasing is a natural outgrowth of the exchange-of-service system, and is usually arranged on the basis of paying a small profit to the farmer above his actual expenses, including taxes, interest, and improvements. Leasing in the past has been mostly to individual sportsmen or clubs, but the system is being developed of late by large organizations of sportsmen dealing with farm groups.

ENTERTAINMENT AND ASSOCIATED PROFITS

The farm that has scenic advantages as well as game may adopt the resort system, which is particularly applicable there. It involves the provision of lodging and services at a profitable rate, the farm's wild-life resources serving as the main attraction to visitors. This system is practicable even for small-farm game management if practiced in such manner as to insure a continuing supply. Many resorts in the past have taken advantage of the natural situation, but have failed to do anything constructive toward maintenance of wild life or improvement of hunting facilities.

DAILY TOLLS

The daily-toll system is in more or less common use in the vicinity of cities, where hunters are numerous and game lands scarce, or where unregulated hunting has been accompanied by intolerable abuses. This system appeals to sportsmen who have no opportunity for leasing hunting grounds or making other permanent arrangements but wish, nevertheless, an occasional half day's hunt over well-stocked and readily accessible coverts. Under this system great care must be taken, however, not to permit reduction of the seed stock. The number of hunters must be strictly regulated, and bags must be in proportion to the game population.

PARTNERSHIP EARNINGS

That system of game management and marketing in which the hunter, as well as the landowner, has a tangible and lasting interest in land improvements made for game is the system most likely to succeed in a permanent way. Without this interest, too many hunters think only of the present day's hunt, and have no regard for preserving sufficient stock for tomorrow and for future years. In the end, then, successful game management is likely to resolve itself into partnerships between farmers and hunters, involving profit to both, rather than into systems dependent upon the sale and purchase of rights only. In fact, the test of successful game management is not whether more game is bagged, but whether, in addition, there still remains more game in the coverts than before management was undertaken. If game management accomplishes this, it is sound; if it does not, it is unsound and will terminate with the extermination of the game.

ESTHETIC RETURNS

Wild-life management has been here referred to primarily as a game-production undertaking, with purposes more or less specific and even mercenary. Its benefits, however, involve species other than game, for bettering game coverts invariably aids wild life in general. This is game management's contribution to the enjoyment of all wild life by the general, nonhunting public.

To most farmers the principal rewards from game management will be those pleasures that they and their families derive from the beautification of the farm and from the presence of a variety of living things. The melodious songs and incessant activities of birds, the drama of the lives of wild things, the companionship that animals somehow give to man—these are among life's real and lasting experiences. Such associations are a profound part of man's attachment to the soil, and are eminently worth preserving for their own sake.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1720

ADOBE
OR SUN-DRIED BRICK
FOR FARM BUILDINGS

IN MANY localities the cost of farm buildings may be considerably lowered through the use of materials obtainable on or near the farm, such as logs, stone, sand, gravel, or earth, which being easily accessible would not involve heavy transportation charges and which, when used in buildings of simple form, do not require the employment of skilled labor.

This bulletin describes the method of making and using adobe in the form of sun-dried bricks. The material consists of a mixture of clayey loam, straw, and water. It is of proven value as a material for walls, its use being traditional in the arid and semiarid areas of the Southwest.

The so-called adobe soils are not essential to this type of construction as most clayey loams are suitable. Nor is the use of adobe construction limited to arid regions; it can be employed in fairly humid climates provided the walls are protected from moisture and the building site is not subject to floods or excessive dampness.

Very comfortable adobe houses have been built with but a small cash outlay and with unskilled labor. Many farmers might well consider the use of this material, at least in certain minor structures.

Washington, D.C. Issued January 1934

ADOBE OR SUN-DRIED BRICK FOR FARM BUILDINGS

By T. A. H. Miller, *agricultural engineer, Division of Plans and Service, Bureau of Agricultural Engineering*

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INTRODUCTION

ADOBE, as a building material, has been employed in the southwestern part of the United States since the time of the early Spanish settlers. It consists of a mixture of clayey loam, straw, or other suitable bonding material, and water. When dried it becomes hard and durable.

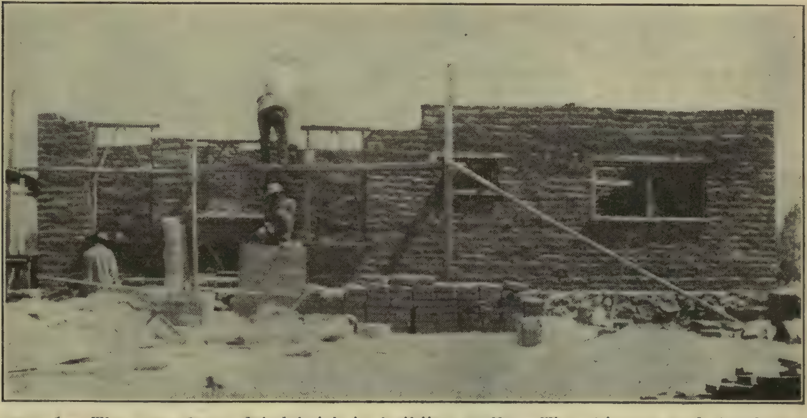

FIGURE 1.—The use of sun-dried brick in building walls. The chimney and fireplace are of the same material.

In this country the use of sun-dried brick (fig. 1) has almost entirely replaced the older custom of piling the mud in layers on the wall and is described and recommended in this bulletin.

The small cash outlay required for materials and the fact that skilled labor is not necessary, permit the construction at a low cost of buildings (fig. 2) which are durable, fire-resistant, and comfortable.

The effective insulation afforded by earth protects interiors from the cold of winter and the heat of summer and makes adobe walls very desirable for many kinds of farm storage. Earth walls are not as subject to sweating as are those of unfurred masonry.

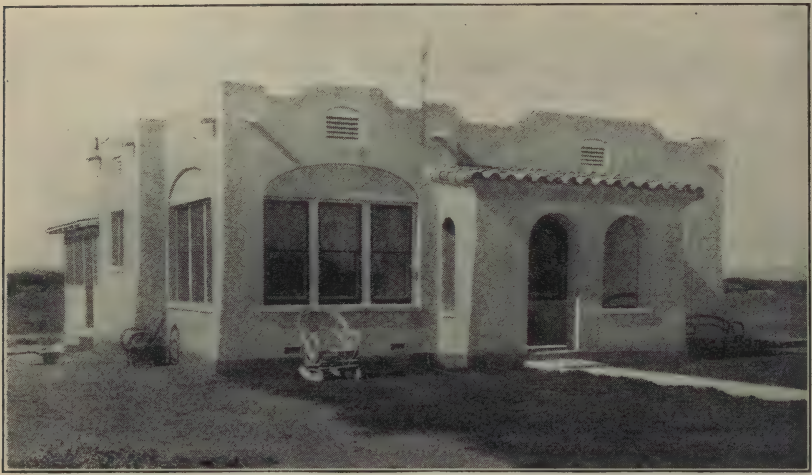

FIGURE 2.—This 34- by 36-foot house without heat, but including oak floors and a 14- by 18-foot garage, was built in 1931 for $3,000.

RELATION TO CLIMATIC CONDITIONS

Builders in the Southwest do not hesitate to use adobe, and in many sections it is preferred to other materials. In the locality of Las Cruces, N.Mex., 80 percent of all structures are of adobe. The extensive use of this material in the arid Southwest is perhaps due to the climate, which is favorable for drying the brick economically

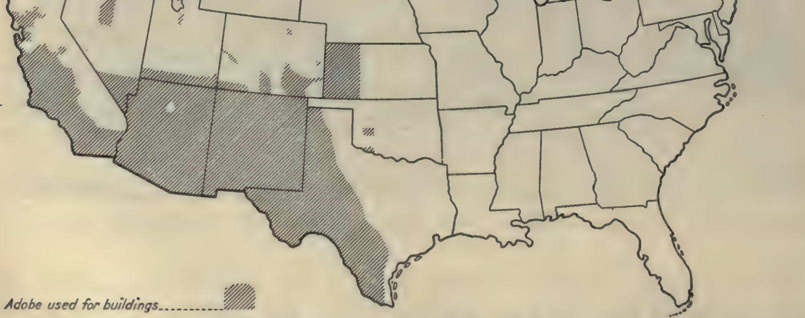

FIGURE 3.—The shaded areas are those in which adobe has been used in building construction.

out-of-doors, and to the fact that it has been used for so many years that workmen have become adept in handling it.

The areas in which adobe construction is practiced are indicated in figure 3. Its use is not restricted to arid areas; it has been utilized also in humid regions having a climate favorable for curing the blocks. In such climates the walls must be well protected against moisture, and the building site must not be subject to flood waters or excessive dampness. The barracks and other buildings at Fort Niobrara, in northern Nebraska, were of adobe brick and stood for many years. An adobe building stuccoed with lime mortar stood for over 150 years near Washington, D.C. There are many buildings of this type in England where the climate is relatively damp.

KINDS OF SOIL

The word "adobe" is used to designate a particular kind of soil and there prevails a general impression that this material is essential for the making of sun-dried brick. Most clayey loams, except those with a high clay content, are suitable, but it is not practicable to make a selection on the basis of soil analyses. Soils having a high clay content shrink or crack badly when drying, and sandy soils do not have sufficient bonding material to prevent crumbling. Neither of these soils should be used alone for brick, but a very good building material can be obtained by mixing the two soils together in proportions that will overcome the undesirable qualities of each. The best way to determine the fitness of a soil is to make a sample brick and allow it to cure in the open, protected from moisture. It should dry without serious warping or cracking. Frequently a suitable earth can be had from excavations for cellars.

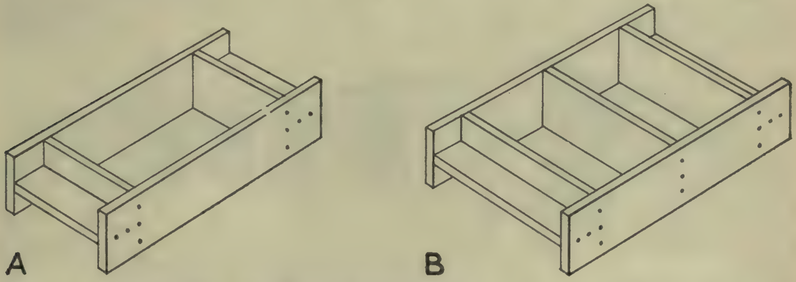

FIGURE 4.—Forms used for molding adobe brick: *A*, Single form; *B*, double form.

MAKING THE BRICK

FORMS

The forms commonly used for molding the brick are shown in figure 4. These are made of lightweight surfaced lumber. Sometimes the inside surfaces are lined with metal to insure brick of true clean-cut shape by preventing adherence of the mud to the sides of the form. Unlined forms are more difficult to clean as the mud has a tendency to stick to wood. The inside dimensions of the forms should be those of the desired brick.

SIZE OF BRICK

The sizes of brick commonly made and their approximate weights are as follows:

4 by 8 by 16 inches, 28 pounds
4 by 10 by 16 inches, 35 pounds
4 by 9 by 18 inches, 36 pounds
4 by 12 by 18 inches, 48 pounds
5 by 12 by 16 inches, 53 pounds
5 by 10 by 20 inches, 55 pounds
5 by 12 by 18 inches, 59 pounds
6 by 12 by 24 inches, 100 pounds

Small bricks are suitable for building poultry houses and other small structures (fig. 5). The 5- by 10- by 20-inch brick is used for 10-inch walls, while the 4- by 12- by 18-inch brick is adapted to building walls from 12 to 30 inches thick. The 6- by 12- by 24-inch brick is too heavy for convenient handling.

PREPARING THE SOIL

Only a sufficient quantity of soil for a day's work should be prepared at one time. The proper amount is piled in a 3- or 4-inch layer, wet thoroughly, and puddled into a mucky mud, generally by men tramping barefooted through the mass, or by mixing with a mortar hoe (fig. 6, *A*). When the earth is uniformly wet, straw is thrown on top in a layer 1½ to 2 inches thick and tramped into the mud. To prevent the straw being worked to the bottom of the pile it should not be added until after the soil has been well puddled. Water is added as necessary to produce a mixture plastic enough to be handled with a 6-tined fork yet stiff enough to stand up upon removal of the form. The quality of the brick is improved by thorough puddling, therefore a hoe should be used in the process.

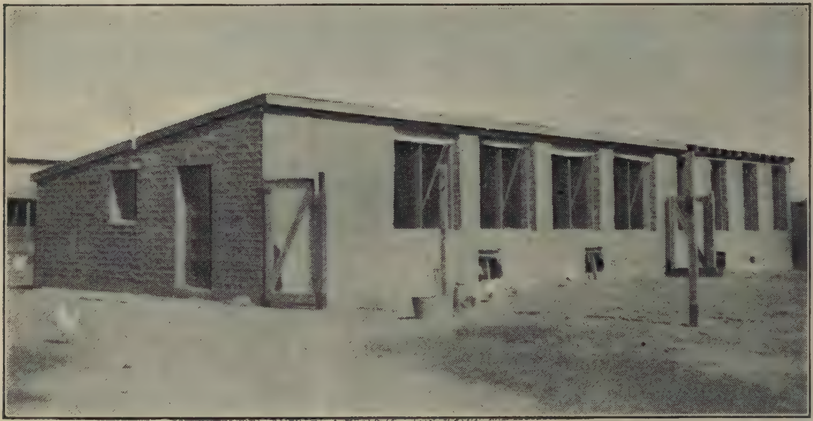

FIGURE 5.—Poultry houses of adobe are in common use in the Southwest. Lime-mortar joints offer resistance to erosion by wind-driven sand.

The amount of straw required varies with different soils and is best determined by experiment. Occasionally brick are made without straw, but generally from a little less than a bale (100 pounds) to 1½ bales per 1,000 brick will be needed depending upon the soil and size of bricks. The quantity should be sufficient to bind the mud and to prevent excessive cracking of the brick while curing. Chaff, horse manure, and chopped hay are preferred by

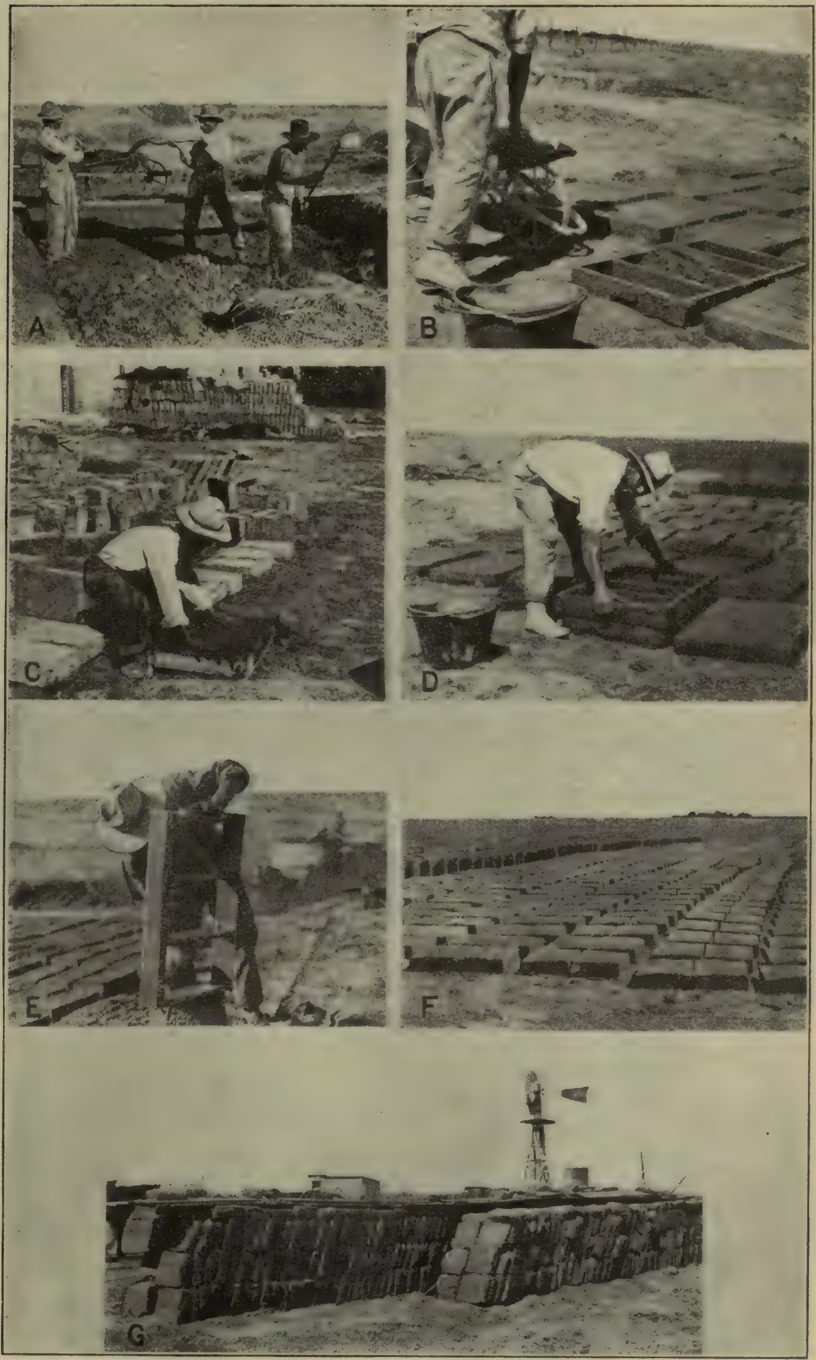

FIGURE 6.—Making adobe brick: *A*, Mixing the soil; *B*, filling forms; *C*, smoothing the top; *D*, removing form; *E*, washing form; *F*, drying the brick; *G*, bricks stacked.

some brickmakers, as long straw is difficult to distribute uniformly through the mass.

Where a suitable prairie sod with tall thick grass is available a 3- or 4-inch layer can be plowed up and puddled without the addition of straw. If a large quantity of mud is required at one time, the first puddling can be done advantageously with a disk harrow and the final mixing by the tramping of horses led back and forth through the pile, by barefooted men, or by working the mud with a hoe. Sometimes homemade horsepower mixers and concrete mixers are used for this purpose.

MOLDING THE BRICK

A fairly smooth area of ground should be selected for the molding site. If ground having a good native sod is not available it is advisable to level off a suitable site and scatter straw over the portion to be used for the molding floor to prevent the brick from sticking to the ground.

The prepared mud is generally conveyed to the molding site in wheelbarrows and forked or shoveled into the forms (fig. 6, *B*). The molder presses it into the form with a tamper or his hands, taking care to fill all corners, and smoothes the top off with a stick or trowel. The form is then lifted away, cleaned of adhering mud, and refilled. If the form does not come off easily, the sides may be loosened from the bricks by tapping.

CURING

In a few days, depending upon the weather, the bricks are stood on edge in such manner as to insure fairly equal exposure of the two sides to the sun and wind and allowed to dry for a week. When dry enough to handle, the loose dirt and straw are scraped from the bottom of the bricks, which are then piled, protected from rain, and left to cure. Two or three weeks are generally required for the brick to dry sufficiently for use.

Brick should not be made in freezing weather or when the season is unsuitable for drying. Care must be taken to protect uncured brick from frost as they will disintegrate if frozen before being thoroughly cured.

RATE OF WORK

Usually 2 to 4 men work together, and each should be able to produce 200 to 250 bricks in 8 hours. The number produced will, of course, vary with the skill of the crew and the convenience of arrangements for handling.

In the Southwest bricks can be purchased ready for use at a cost varying from $18 to $30 per thousand depending upon the size and local demand. Suitable soil is usually sold for $1 to $1.50 per 1,000 bricks.

METHOD OF LAYING BRICK

Adobe brick are laid in the wall in much the same manner as are ordinary burnt brick (fig. 7), care being taken to break joints and to build up strong, well-bonded corners. Generally mud without straw is used for mortar, and the bricks are laid with ½- to 1-inch joints. Mortar made by mixing 1 part lime and 3 parts sand is frequently used in the more permanent structures. While higher in cost than mud, it makes a stronger wall and also provides a good key for holding the stucco.

About 1 cubic foot of mortar or mud is required to lay 25 to 30 bricks 4 by 10 by 16 inches in size, with ½-inch joints. A crew of 3 men should place between 600 and 700 bricks in the wall in 8 hours.

The number of bricks required to build 100 square feet of wall depends upon the size of the bricks and whether the end or side is exposed; thus, when 4- by 10- by 16-inch bricks are laid with ½-inch joints, 305 are needed for 100 square feet of wall 16 inches thick, and 190 for the same area 10 inches thick.

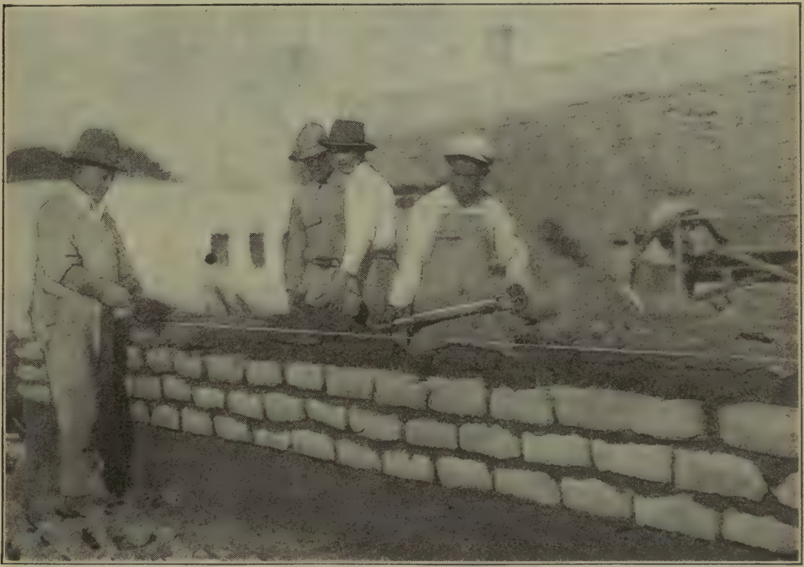

FIGURE 7.—Laying adobe brick in mud mortar.

Nailing blocks and anchor bolts for securing frames, trim, sills, and plates are required as in other types of masonry and are built in as the wall is raised. Sometimes bolt holes are bored with an auger and the bolt bedded in the hole with cement mortar.

The height to which a wall may be carried depends upon its thickness and whether or not buttresses are used at frequent intervals to serve as braces. A warehouse 100 by 400 feet built at Clint, Tex., has walls 18 inches thick and 40 feet high, while 2-story dwellings having 16-inch lower walls and 12-inch upper walls are not uncommon (fig. 8).

Bearing walls should be not less than 12 inches thick, and it is advisable to limit the story height to 12 feet. To avoid possible damage by wind during construction, it is advisable to brace high, long walls temporarily until they have been permanently secured by plates, and ceiling or floor joists.

FOUNDATIONS

A good watertight foundation is essential for all permanent buildings and especially for those made of adobe, which deteriorate rapidly when subjected to continued moisture or the occasional erosive action of water (fig. 9). In general, foundations similar to those used for masonry walls are suitable. Inexpensive foundations are shown in figure 10.

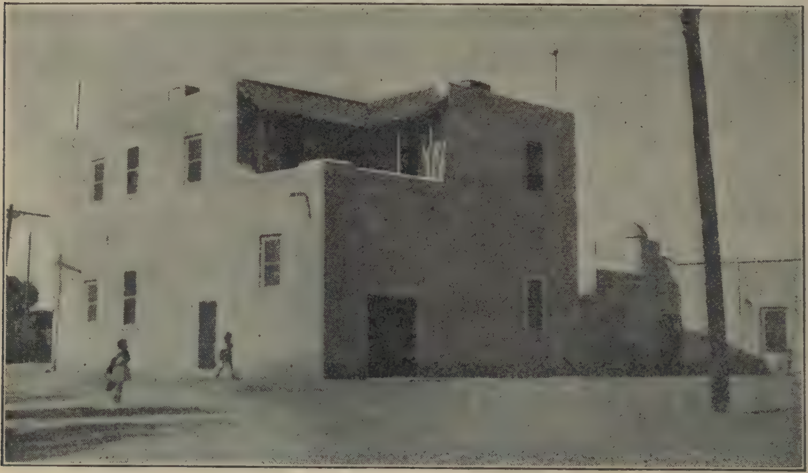

FIGURE 8.—Two-story apartment house of stuccoed adobe.

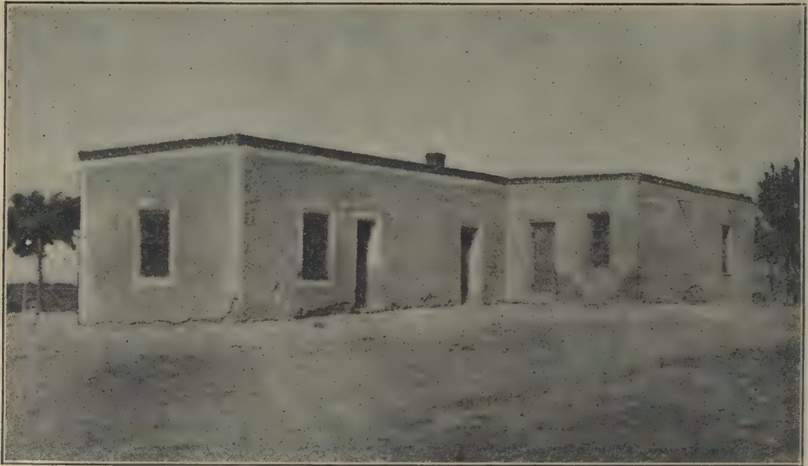

FIGURE 9.—Better type of house built by Mexicans. Lack of masonry foundation and protection at the ground caused the lime stucco to fail. This defect should be repaired as suggested in figure 10. The decorative coping of burnt brick, the short chimney carried by the wall, and the roof outlets are features of interest. This house is more than 50 years old.

The following recommendations should be followed in order to secure stability and protection of the earth walls:

All footings should be carried below the frost line and to solid ground.

Footings should be wide enough to distribute the wall loads uniformly to the soil upon which they rest and within the limit of the bearing power of the soil.

Foundations should be of watertight concrete or of stone or brick laid in cement mortar, and of a proper size to bear the imposed weight. In arid localities waterproofed adobe foundations may be used for minor structures.

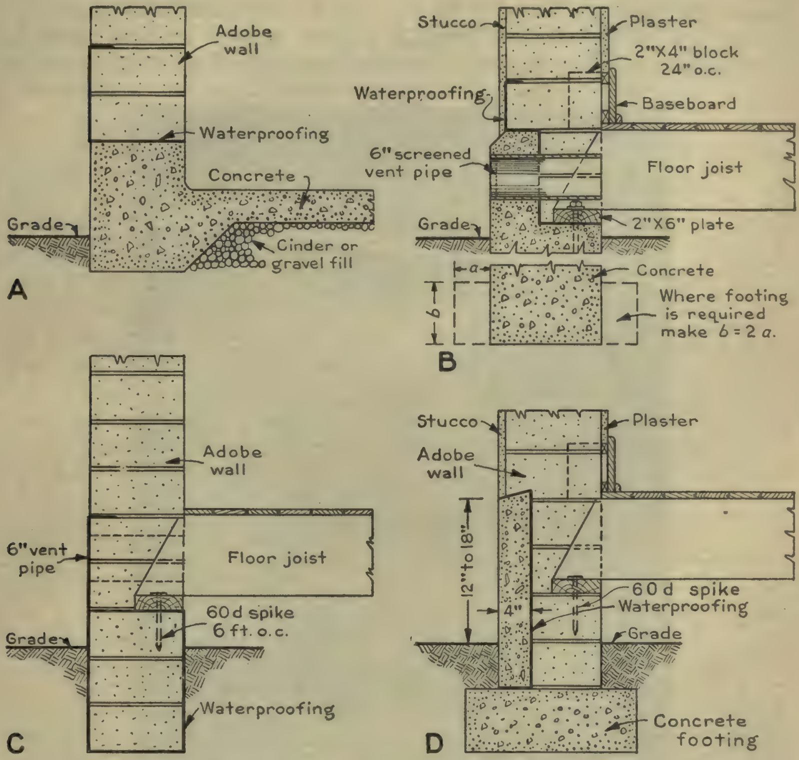

FIGURE 10.—*A*, Shallow footing suitable for dry climates, where it will not be subject to undermining by surface drainage. Outside waterproof protection is provided for walls which are not stuccoed, and an inside curb to keep the earth dry when the floor is cleaned with water. *B*, Suggested footing for thick walls. It provides full bearing for the adobe wall and protects the outer portion from erosion. *C*, Adobe foundations for minor structures are afforded a fair measure of protection from ground moisture by heavily coating the bottom of the excavation and both sides of the bricks with tar. The excavation must be made wide enough to permit application of the tar to the wall surfaces. The walls and trench bottoms could be plastered to advantage with 1 inch of 1 : 2½ cement mortar. *D*, Method of repairing walls eroded near the grade line. The adobe bricks are cut out for a depth of 4 inches and replaced with a concrete base extending below, and at least 12 inches above, the grade.

The tops of foundations should be at least 12 inches above the outside grade, and 6 to 8 inches (fig. 10, *B*) above concrete floors, to protect the earth walls from the splash of rain and of water used in cleaning the floors.

A dampproof course, as described in Farmers' Bulletin 1572, Making Cellars Dry, should be provided on top of the foundation to prevent moisture rising by capillarity from the ground into the adobe.

Screened openings (fig. 10, *B*) should be provided in the foundations for ventilation of the space under wood floors. They should be placed about 10 feet apart.

The tops of foundation walls should provide bearing for the first-floor joists and full bearing for the adobe brick of the wall above (fig. 10).

Although adobe is frequently used in dry climates as a foundation material for small dwellings and minor utility buildings, this is not recommended as a general practice because the splash from rain and roof drainage, and erosion by wind may seriously damage the earth walls. Where expediency warrants this type of foundation, a well-drained site should be chosen, the lower portion of the wall should be protected by cement stucco or by some other method of waterproofing (fig. 10, *D*), and special provision should be made to carry roof drainage away from the walls and footings.

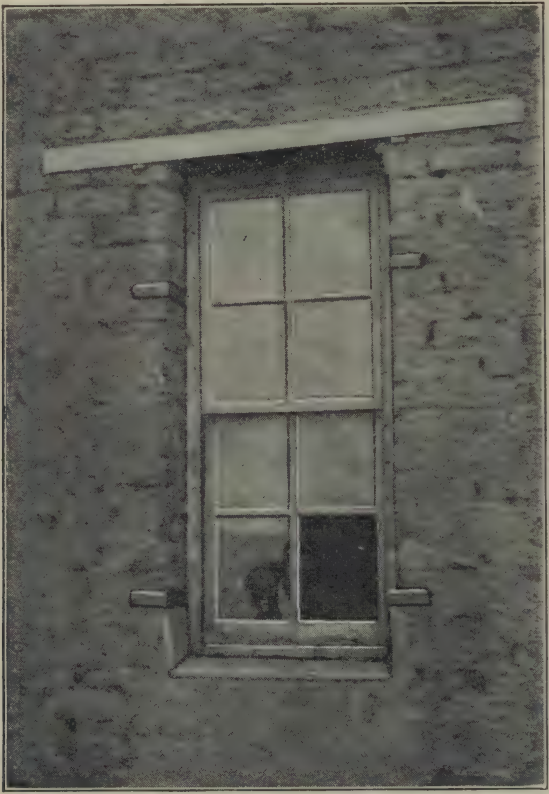

FIGURE 11.—Blocks at the sides of openings to which window and door frames are secured. These should be hidden by the brick unless outside trim is to be applied. The small blocks through the wall under the lintel are recommended as insurance of a uniform bearing.

WINDOWS AND DOORS

Door and window frames usually are set in place and the walls built against them, but it is rather difficult to fasten the frames securely so as to prevent their working loose as the walls dry and settle. Blocks consisting of 2- by 4-inch lumber, 12 inches or more in length, built into the earth walls and to which the frames are nailed (fig. 11), are fairly satisfactory; there should be three blocks on each side of the opening. Sometimes a rough frame is bolted to the wall, the finished frame being nailed to it. When the wall is to be plastered or stuccoed, provision should be made to return the stucco under the trim in order to secure weathertight joints (fig. 12).

Lintels are required over openings to carry the wall above, the roof rafters, and second-floor joists. They may be of the same materials and dimensions as would be used under like conditions in masonry walls. They should extend 9 to 12 inches beyond the jambs to afford proper bearing on the adobe (fig. 11). Lintels should be set one half to 1 inch higher than the window or door frame to allow for settlement in the wall.

Arches can be built of adobe brick cut to the required shape or formed in special molds (fig. 13).

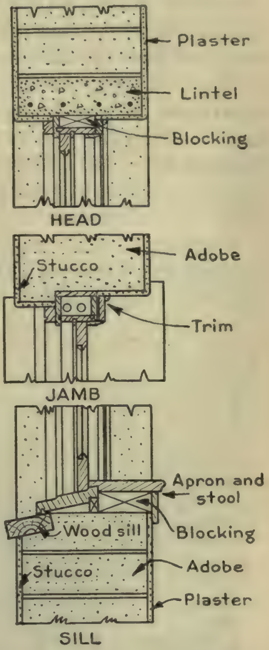

FIGURE 12.—Detail of window.

A very good practice in adobe construction is to place 2-inch planks, as wide as the wall, around the building just above the lintels, to prevent uneven settlement and to tie the brickwork together lengthwise.

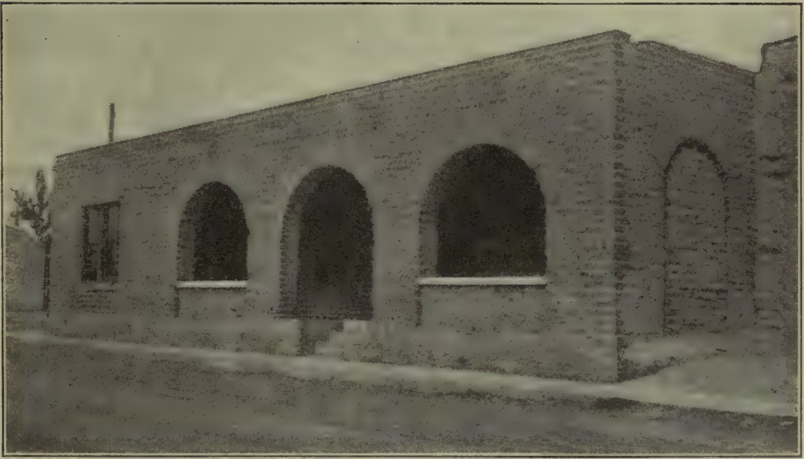

FIGURE 13.—Adobe brick arches, laid in lime mortar, with a span of 6 feet between 12- by 24-inch columns.

OUTSIDE AND INSIDE WALL COATINGS

OUTSIDE TREATMENTS

Uncoated adobe walls (fig. 14) will last from 25 to 40 years in arid climates if the top and base are protected from moisture. However, an outside coating increases the durability and improves the appearance of the structure, and is essential in humid localities.

No covering has been developed as yet that has the four desired qualities of good appearance, watertightness, durability, and cheapness. Bituminous coatings are very satisfactory in many respects but on account of their dark color are not acceptable as finish. Hot tar, cold-pitch asphalt, and Cunningham coal-tar paint are coatings of this type.

Cunningham coal-tar paint is a mixture of 1 part portland cement, 1 part kerosene, and 4 parts coal tar by volume. The cement and kerosene are mixed separately and then stirred into the tar. The paint is applied with a brush or swab. The tar should be the liquid procured from local gas works or naval supply stores, known as water-gas tar. It is not the pitch ordinarily used which requires heating or thinning with a solvent. The consistency can be modified by reducing the amount of cement or by increasing the quantity of kerosene. An excess of cement produces a thick paste which has value in stopping holes not filled by paint of normal consistency. It is better to use the paint immediately after mixing, although it can be held for a considerable time if kept in closed receptacles so that the kerosene will not evaporate.

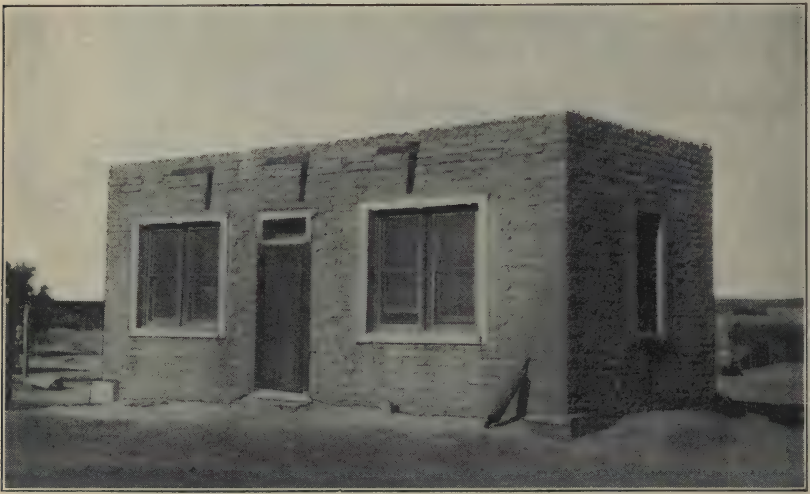

FIGURE 14.—Uncoated adobe walls 25 years old. This 14- by 24-foot house could be built in 1931 by contract for $300. If the owner made the brick and did all the work it could be built for $150 cash.

The use of Cunningham coal-tar paint by the Bureau of Agricultural Engineering in waterproofing rammed earth walls indicates that it may have considerable merit in adobe construction. Before any of these are applied the walls should be primed with two coats of thin water-gas tar. The final appearance may be improved by an application of aluminum paint over the whole surface or as a trim. Ordinary paints cannot be used successfully over tar or asphalt.

Whitewashes are cheap, easily applied, and decorative when fresh (cover illustration). They are not very durable or waterproof but are frequently used for low-cost structures. Farmers' Bulletin 1452, Painting on the Farm, and Farmers' Bulletin 1500, Rammed Earth Walls for Buildings, contain formulas for whitewash and other coatings.

Linseed oil paint is durable, waterproof, and decorative, but is rather expensive. Three coats are recommended for first-class work. The first and second coats should contain an excess amount of oil to penetrate and bond the earth surface. If the walls are to be painted, care should be taken in making and laying the brick to provide a smooth wall surface as it is difficult to paint over rough adobe brickwork.

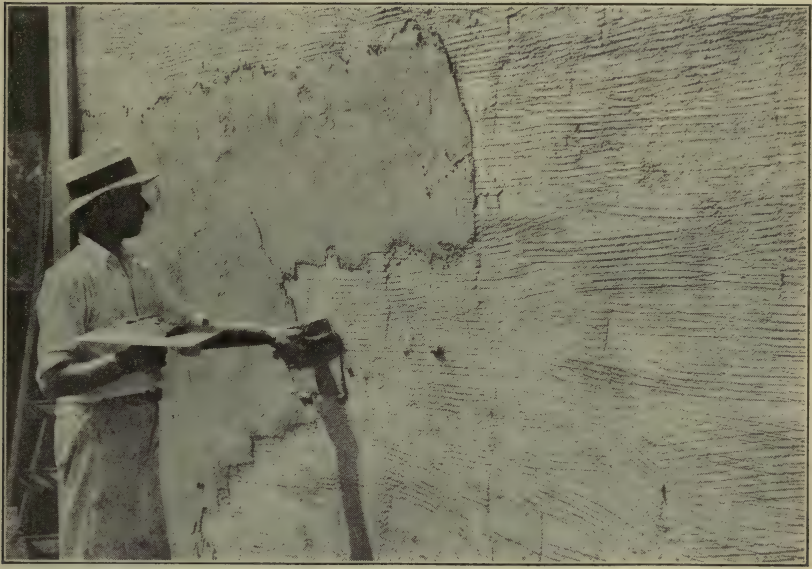

FIGURE 15.—The undercoats of both stucco and plaster should be scored or scratched to form a bond for succeeding coats.

Frequently in low-cost buildings the walls are plastered with mud mortar. If the mud is rich in clay, 1 part sand is mixed with 2 parts mud to minimize shrinkage cracks. This mixture will adhere to earth walls better than lime mortar and when dry forms a good base for paint or whitewash especially if waterproofed.

Stuccos and inside plasters should not be applied for at least 2 months after a wall is built, to allow for settling and shrinkage. Unless the wall is very smooth and free of irregularities, the stucco should be put on in 2 coats or layers, and 3 coats are recommended for first-class work. All undercoats should be heavily scored (fig. 15) to provide bond for succeeding coats.

A bond or key should be provided to increase the adherence both of outside stucco and of inside plaster to earth walls. As stated previously, the protruding joints of lime mortar have considerable value in this respect. Figure 16 illustrates a method of using nails as a bond for stucco or plaster. For first-class permanent work, metal lath should be provided as a base for stucco.

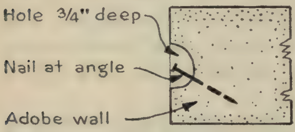

FIGURE 16.—Holes about three fourths of an inch deep in each block are made by striking the adobe with a sharp tool. Eight-penny, or ten-penny nails are driven in, at an angle to prevent their pulling out, so that the heads are flush with the wall and out of the way of the trowel when the plaster is applied.

Stucco thrown onto the wall from a broom or a brush made of reeds (fig. 17) will adhere more firmly than if spread with a trowel. Most plasterers prefer to apply only the first coat by this method because of the difficulty of securing uniform thickness.

Stucco made by mixing 1 part lime putty and 3 parts sand, by volume, is fairly durable and adheres to earth walls better than does portland-cement stucco. When properly applied lime stucco has greater resistance to water than is commonly supposed, but being softer than cement stucco it is not so durable when subjected to erosion by wind-borne material or to continued moisture.

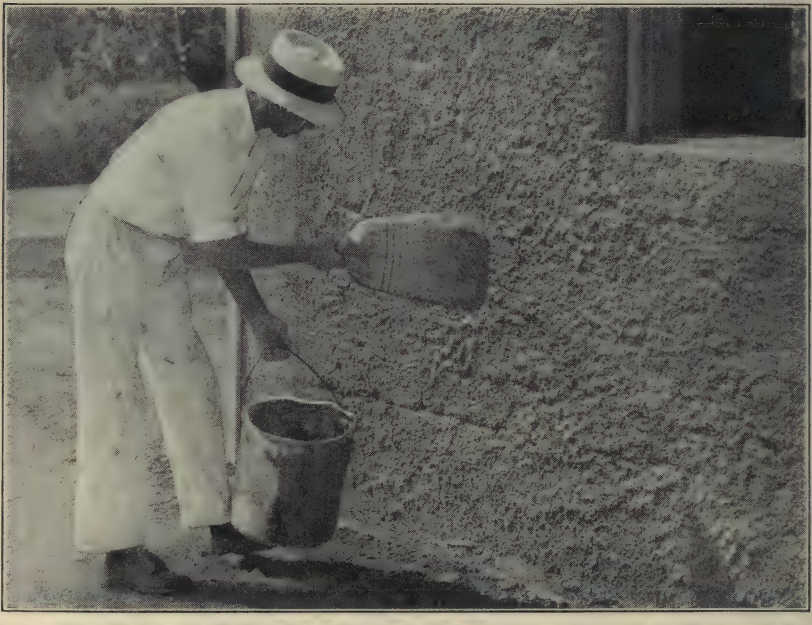

FIGURE 17.—Mortar applied with a broom adheres more firmly than if troweled on. Undercoats should be applied by this method so as to form a good bond for the troweled finish.

Portland-cement stucco made by mixing 1 part portland cement and 3 parts sand, by volume, is advisedly used to resist water and mechanical wear but is applied preferably over metal lath to minimize the tendency to crack. It can be handled to better advantage if, for each bag of cement, 10 pounds of hydrated lime (or the equivalent in lime paste) is incorporated in the mortar.

Ten pounds of hydrated lime is equivalent to about one fourth cubic foot; 1 cubic foot of the paste requires 44 pounds of hydrated lime or 27 pounds of quicklime. Hydrated-lime paste should stand for at least 24 hours to insure complete slaking. Quicklime should be slaked at least a week before it is used, the longer the better. Hydrated lime, in powder form, is nearly two and one half times as bulky as portland cement, weighing 40 pounds per cubic foot as compared with 94 pounds for cement.

To produce good stucco, care must be taken to prevent too rapid drying. Wetting the walls prior to stuccoing or plastering and covering the finished surface with wet bags or spraying it with water for several days will reduce its tendency to crack.

The texture or finish of stucco depends upon the manner of working the final coat. Directions for applying and finishing cement and lime stucco may be found in trade publications.[1]

INSIDE TREATMENTS

The inside wall surfaces of smaller farm buildings frequently are not plastered. A plaster consisting of 1 part sand and 2 parts clayey loam may be applied to secure a smooth surface. This mud plaster is fairly durable if kept dry. Sometimes a skim coat of lime or cement mortar is applied over the mud base to improve appearance and wearing quality. A cheap, durable, and decorative finish may be obtained by covering the mud plaster with paint, calcimine, or paper.

Lime mortar or commercial plasters, applied over metal lath, should be used on the interior walls of residences or wherever a better finish is desired.

Because animals have the habit of licking earth walls and rubbing against them, the corners of buildings should be protected by corner boards and the door jambs by casings. The use of portland-cement mortar for laying the bricks at corners within reach of animals might discourage the habit and prevent damage. Interior surfaces within reach of animals tied or penned, as in a stall, should be protected by a well-sanded tar coating or by cement plaster.

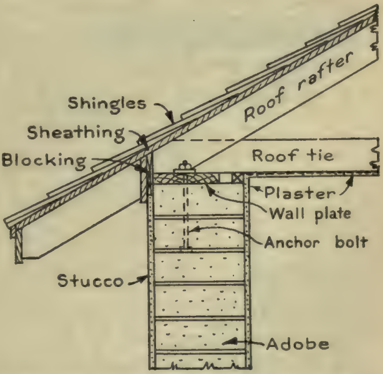

FIGURE 18.—Anchoring roof to wall.

ROOFS

All kinds of roofing are used on adobe buildings. The chief considerations are low cost, watertightness, and protection of the earth walls. Sloping roofs with wide eaves afford the greatest protection from damage by rains. Only such roofs, securely anchored to the walls (fig. 18), should be employed in humid localities.

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[1] Portland Cement Association, Chicago, Ill., and National Lime Association, Washington, D.C.

Unless the roof is well insulated,[2] much of the insulating value of the earth walls is nullified. Metal roofing alone provides no insulation and in cold climates will sweat when used on animal shelters or on heated storages where moisture is present. Water formed by condensation will drip on the walls, floors, products, or animals, causing annoyance and, in time, serious damage.

Flat roofs with parapets are very popular in arid regions because earth can be placed upon the roof covering as insulation against the hot sun. In humid localities, where earth cannot be used as an insulator, the roof should have a slight pitch to shed rain water and should be insulated with one of the commercial materials manufactured for this purpose. Explicit directions for the application of different kinds of insulating and roofing materials can be had from the manufacturers of the various products.

Metal can be used to cover flat decks, but the seams must be made watertight with solder and the surface must be kept well painted. Good built-up roofing is very satisfactory on flat roofs and is commonly used. This consists of 4 or 5 layers of waterproof felt laid alternately with hot tar or asphalt coatings, the top being covered with gravel, slag, or, in dry climates, earth.

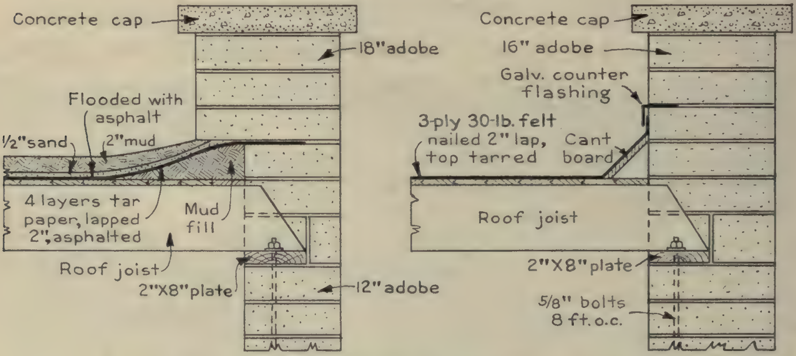

FIGURE 19.—Two methods of building flat roofs.

Although good quality built-up roofing is more expensive than the coverings widely employed in the so-called "adobe" region of the Southwest, it compares favorably with metal and other long-life coverings and may be used on flat-roofed houses of the better class. Great care must be exercised to provide tight flashings around parapets, chimneys, etc., and ample drainage outlets. Outlet troughs 3 feet long, shown in several of the illustrations, are commonly used on small buildings to throw the roof drainage away from the base of the wall.

Two roofs which have given good service in New Mexico are illustrated in figure 19. Very cheap roofs, suitable only for regions having little or no rainfall, consist of metal sheets laid over the rafters with or without sheathing and covered with sod or earth. The life of the metal can be extended by painting both sides with Cunningham coal-tar paint (p. 12). The tops of parapets should be water-proofed and protected against erosion by a masonry cap. In arid regions adobe bricks are used for this purpose on low-cost houses (fig. 14), but this necessitates keeping a supply of brick on hand for frequently needed repairs.

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[2] House Insulation and Insulation on the Farm, two pamphlets by the National Committee on Wood Utilization, U.S. Department of Commerce, may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C., for 10 cents each.

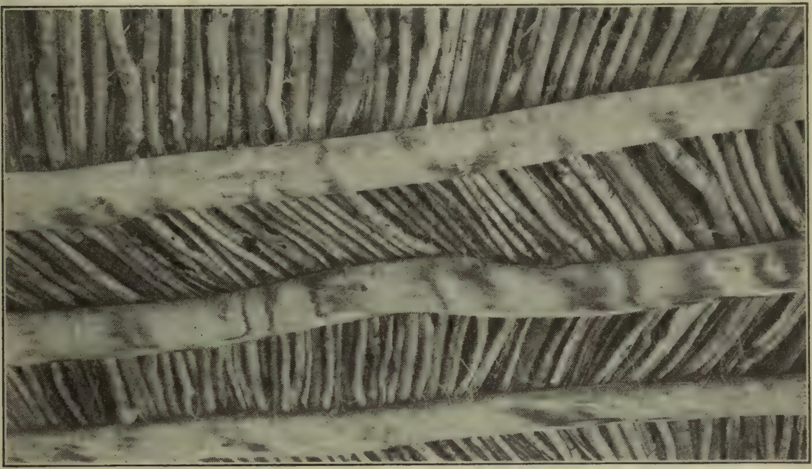

FIGURE 20.—Under side of a roof consisting of cottonwood logs 4 to 8 inches in diameter spaced 24 to 30 inches on centers and covered with 1-inch willow twigs laid diagonally as support for a layer of dry rushes or straw held in place with 2 to 4 inches of adobe mud or sod.

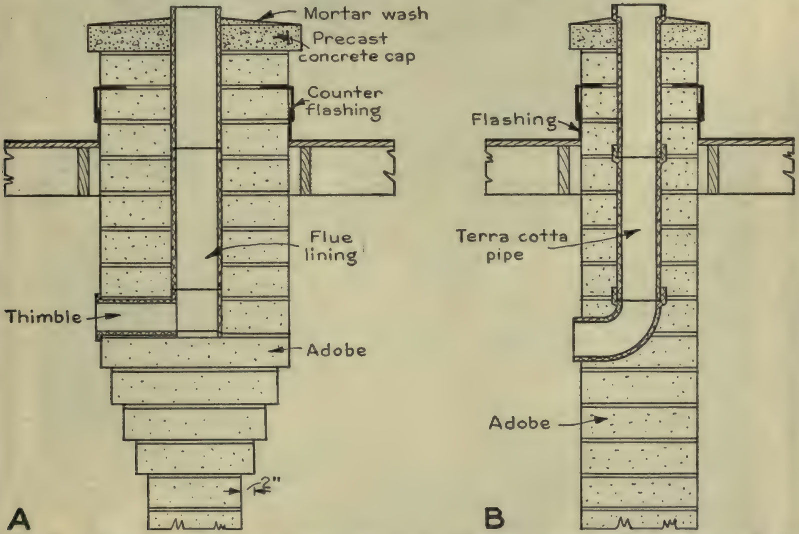

FIGURE 21.—Chimneys built of adobe bricks: *A*, Corbelling to obtain thick walls which lessen the fire hazard due to erosion of mortar in the joints: *B*, in very cheap houses and shelters a 6-inch glazed tile is often built into the adobe wall as shown.

An interesting type of roof used on pioneer buildings is illustrated in figure 20. While such a roof can be made tighter than might be expected, it is suited only to secondary sheds, porches, and temporary buildings, unless sheathing is used over the 1-inch branches instead of the customary cane or straw and a durable covering over the sheathing.

CHIMNEYS

Chimneys for better-class buildings should be constructed in accordance with generally accepted good practice. They should rest on firm foundations extending below the action of frost. Farmers' Bulletin 1649, Construction of Chimneys and Fireplaces, gives complete directions.

Adobe is frequently used for chimneys and fireplaces, but when so employed the inside of the fireplace should be lined with fire-clay brick and the flues with flue lining. Chimneys with 4-inch walls of burnt brick, lined with terra cotta, are frequently to be found in adobe houses. Where walls are thick and only a short chimney is required, it can be safely built as shown in figures 21 and 22. The tops of chimneys should be capped with masonry.

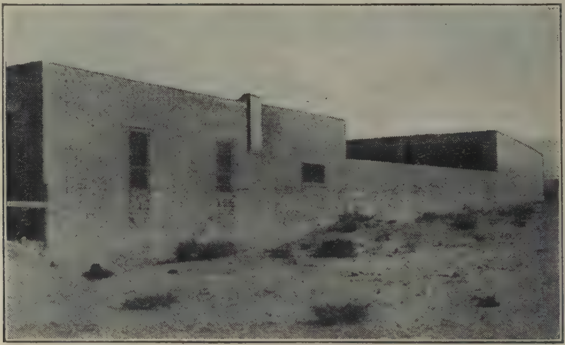

FIGURE 22.—Exterior view of chimney such as shown in figure 21, *A*.

BOUNDARY WALLS

Adobe can be used economically for fences and boundary walls and, in arid sections, will last longer than the average fence even when foundations and stucco are omitted. If stuccoed and provided with a good foundation and cap they are ornamental and very durable.

U.S. GOVERNMENT PRINTING OFFICE: 1933

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1721

DETERMINING THE AGE OF FARM ANIMALS BY THEIR TEETH

1862 1889

LIVESTOCK owners and buyers of market animals often find it desirable to determine the approximate age of the animals. This can be accomplished in most instances by a careful examination of the teeth.

This publication shows how to determine, by the size and condition of the teeth, the approximate age of farm animals from early life to maturity and, in many cases, even in old age.

This bulletin is a revision of and supersedes Farmers' Bulletin 1066, Determining the Age of Cattle by the Teeth.

Washington, D.C. **March 1934**

DETERMINING THE AGE OF FARM ANIMALS BY THEIR TEETH

By George W. Pope, *chief, Field Inspection Division, Bureau of Animal Industry*

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IMPORTANCE OF DETERMINING THE AGE OF FARM ANIMALS

THE PRODUCTIVE LIFE of farm animals is comparatively brief, the height of their usefulness being limited to a few years. For this reason the returns from livestock tend to decrease with advanced years. The age of animals, therefore, is a matter of utmost importance to the breeder, the seller, and the buyer.

Physical changes within the body are constant. They affect the general outward appearance and disposition and, within certain limitations, it is not difficult by mere general appearance to distinguish the young animal from one that has reached maturity, or even to determine the approximate age of an old animal. Changes which take place in the teeth, however, afford the best opportunity of determining the age.

Establishing the age of farm animals through the appearance of the teeth is no new thing. The possibility of judging in this manner apparently was well known in ancient days. The old saying, "Do not look a gift horse in the mouth", is attributed to Saint Jerome, of the fifth century, who used this expression in one of his commentaries. Certainly for generations the appearance, development, and subsequent wear of the teeth has been recognized as a dependable means of judging approximately the age of animals.

With a knowledge of the age at which the teeth appear, the time for shedding temporary or milk teeth and their replacement with permanent teeth, and the changes in form which result from natural wear, the approximate age of farm animals can be determined. Theoretical knowledge, however, is not sufficient, and any one who would become proficient must also have practical experience. This bulletin describes briefly the normal processes of dentition and the changes which time brings about, and explains how to determine the ages of animals by examining their mouths.

HORSES AND MULES

The ordinary observer can readily learn to tell the age of horses or mules with considerable accuracy until the animals have passed their eighth year. Beyond this time even those who are experienced may find it difficult to determine the exact age.

The mature male horse has 40 teeth (fig. 1). Twenty-four of these are molars or grinders, 12 are incisors or front teeth, and 4 are tushes or pointed teeth. The 2 central incisors are known as centrals or nippers; the next 2, 1 on each side of the nippers, are called intermediates or middles, and the last, or outer pair, the corners. The tushes are located between the incisors and the molars. They are not usually present in the mare, and accordingly she may be considered to have a total of 36 teeth rather than 40, as in the male.

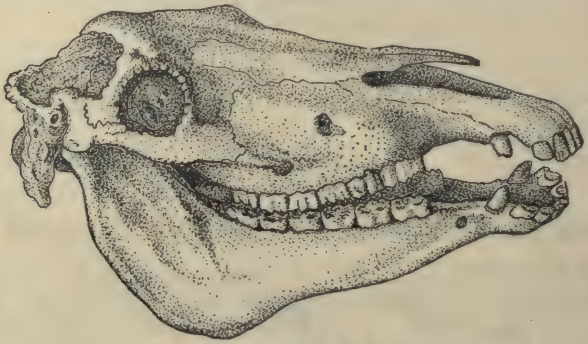

FIGURE 1.—Skull of the horse (from Frateur).

The young animal, whether male or female, has 24 temporary teeth, commonly called milk teeth, as they are much whiter than the permanent teeth. These milk teeth consist of 12 incisors and 12 molars. The latter are the 3 back teeth on each side of both the upper and the lower jaw. The milk teeth are shed and replaced by permanent teeth at fairly definite periods, which serve as an index in determining the age of young colts.

The temporary central incisors or nippers may be present at birth (fig. 2, *A*); otherwise they appear before the colt is 10 days old. There are two in each jaw.

At the age of from 4 to 6 weeks the two temporary intermediates, upper and lower, appear (fig. 2, *B*). These teeth immediately adjoin the nippers.

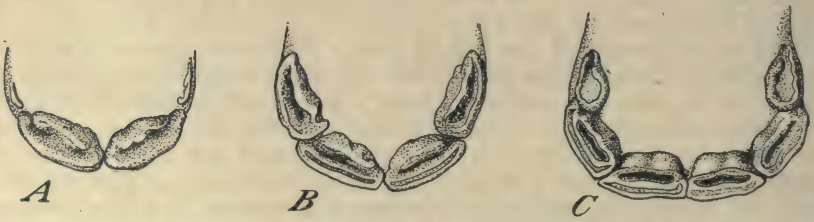

FIGURE 2.—Temporary incisor teeth of a young colt: *A*, Immediately after birth; *B*, at 6 weeks; *C*, from 6 to 10 months after birth.

When the colt is from 6 to 10 months old the corner or outer incisors, two above and two below, are cut (fig. 2, *C*). This gives the young animal a full set of temporary front teeth.

By the time the colt has reached the age of 1 year the crowns of the central incisors show wear (fig. 3, *A*). In another 6 months the intermediates or middles become worn (fig. 3, *B*), and at 2 years all the teeth are worn (fig. 3, *C*). During the following 6 months there are no changes which will distinguish the exact age. At about 2½ years, however, the shedding of the milk teeth begins and at 3 years the temporary central nippers, two above and two below, are replaced by the permanent central incisors.

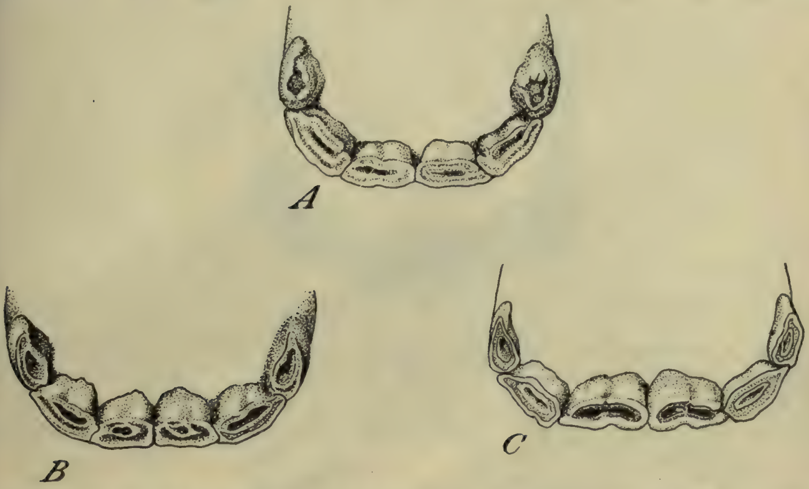

FIGURE 3.—Appearance of the incisor teeth of a colt: *A*, At 1 year; *B*, at 18 months; and *C*, at 2 years.

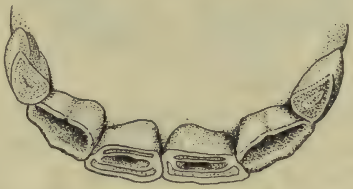

FIGURE 4.—Incisors of a horse at 4 years. The permanent incisors are the four in the center, and the temporary ones are at the corners.

At 4 years the four permanent intermediates have taken the place of the four temporary middles (fig. 4).

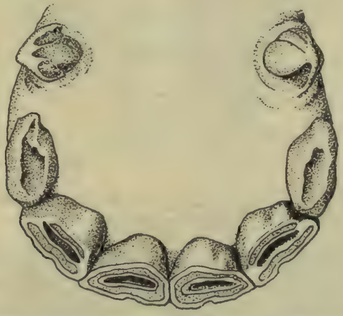

FIGURE 5.—Permanent incisors of a horse at 5 years. The tushes also shown here indicate that the animal is a male.

When the animal is about 4½ years old the shedding of the four corners begins, and at 5 years the permanent teeth which replace them are well up but not in contact (fig. 5).

In a 6-year-old horse the corner incisors are on a level with the adjoining teeth, with a well-marked dental cavity or "cup" showing practically no wear (fig. 6). The nippers show wear over the entire surface; the "cup" though visible shows indications of gradual disappearance and at this stage is without a hollow.

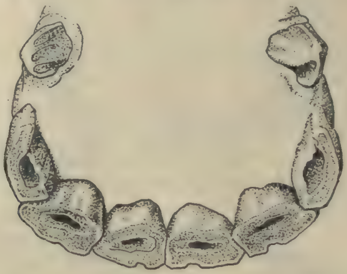

FIGURE 6.—Incisors of a horse at 6 years.

When the animal is 7 years old, not only the nippers but also the middles show wear (fig. 7). Each upper corner tooth has an indentation caused by wear from the corresponding lower tooth, resulting in a downward triangular projection of the posterior edge. This projection is commonly termed "dovetail" (fig. 8).

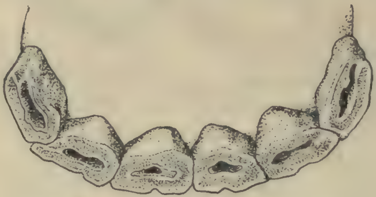

FIGURE 7.—Incisors of a 7-year-old horse.

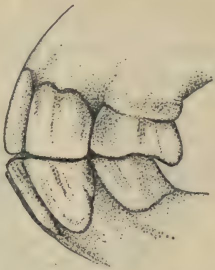

FIGURE 8.—Side view of incisors of a 7-year-old horse. Note, in upper corner incisors, the notch which appears at this age.

In the 8-year-old horse all the incisors are worn, the cup has entirely disappeared from the nippers, but shows to a slight extent in the middles, and is still well marked in the corners. At this stage what is termed the "dental star" makes its appearance as a yellow transverse line just back of the front edge of the table, or flat surface, of the nippers and middles (fig. 9).

Between the ages of 9 and 13 years there is a gradual change in the contour of the tables of the incisors. In a 9-year-old animal the nippers take on a more or less rounded contour; the dental cavity or cup has disappeared from all but the corners; the dental star is found in both the nippers and middles and in the former is near the center of the table (fig. 10). At 10 years the middles become rounded, and the dental star, now seen on all the incisors, is near the center of both the nippers and middles (fig. 11). At 11 or 12 years the corners have a somewhat rounded form, and the dental star approaches the center of the table (fig. 12). As the horse reaches 13 years of age all the

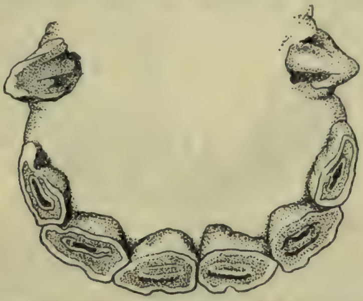
FIGURE 9.—Incisors of 8-year-old horse. Dark line in front of cup is the dental star.

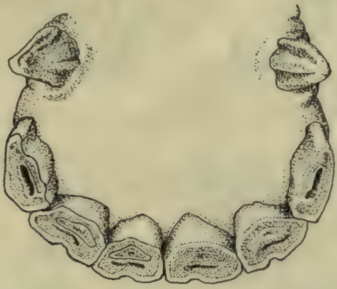
FIGURE 10.—Incisors of a male horse 9 years old.

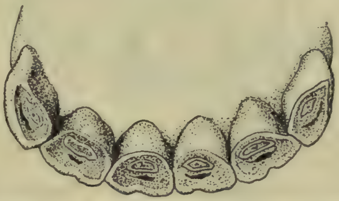
FIGURE 11.—Incisors of a horse at 10 years.

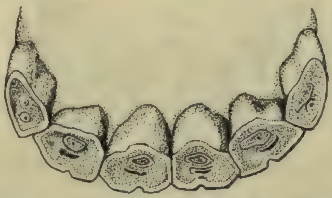
FIGURE 12.—Incisors of a horse at 11 or 12 years.

lower incisors are unmistakably rounded, the dental star is found in the center of all the tables, and the enamel rings which formerly surrounded the cups have entirely disappeared (fig. 13).

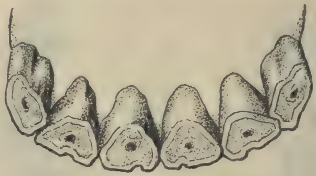

FIGURE 13.—Incisors of a horse at 13 years.

In a horse about 14 years of age the tables of the incisors begin to change from a rounded to a triangular contour. This change occurs in the nippers at 14 years (fig. 14), in the middles at 15 years, and in the corners at 16 or 17 years (fig. 15).

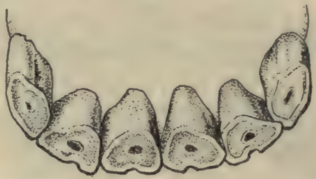

FIGURE 14.—Incisors of a 14-year-old horse.

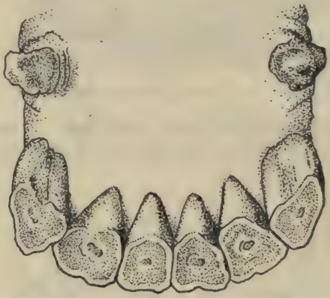

FIGURE 15.—Incisors and tushes of a male horse at 17 years. The mouth of a female has the same appearance except for the absence of tushes.

During the following 4 years after the appearance of the triangle, there is a gradual approach of the tables to the form of a rectangle, as shown in figure 16. The teeth during this period are usually elongated and directed obliquely. The dental arch also becomes contracted and pointed and the under edges of the lower jaw are thin and sharp as compared with their appearance in a young horse (fig. 17).

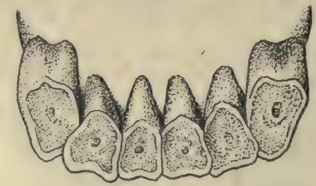

FIGURE 16.—Characteristic shape of an old horse's lower incisors at 18 years.

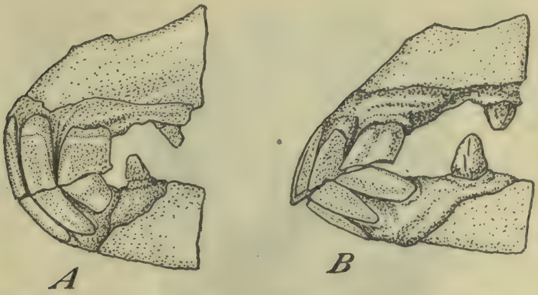

FIGURE 17.—Comparison of incisors and tushes of horses at different ages: *A*, At 6 years, and *B*, at 20 years.

Should the animal live more than 20 years, these conditions become more marked and are accompanied by excessive wear and loosening or loss of molars.

CATTLE

Cattle at maturity have 32 teeth, of which 8 are incisors. All incisors are in the lower jaw (fig. 18). The two central incisors are called pinchers; the next two, first intermediates; the third pair, second intermediates or laterals; and the outer pair is known as the corners. In place of the upper incisor teeth there is a thick layer of the hard palate called the dental pad (fig. 19).

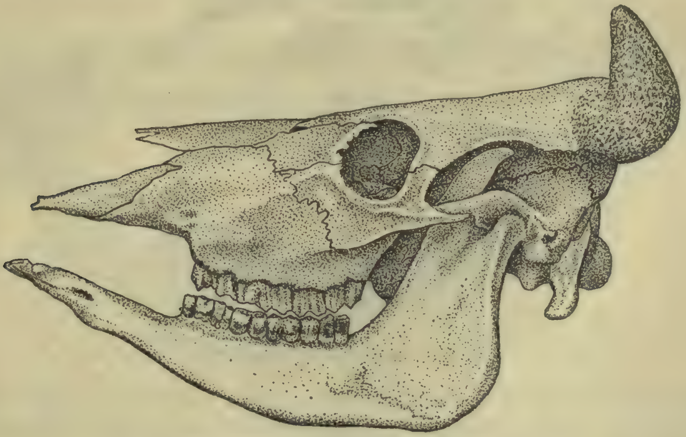

FIGURE 18.—Skull of an ox (from Sisson).

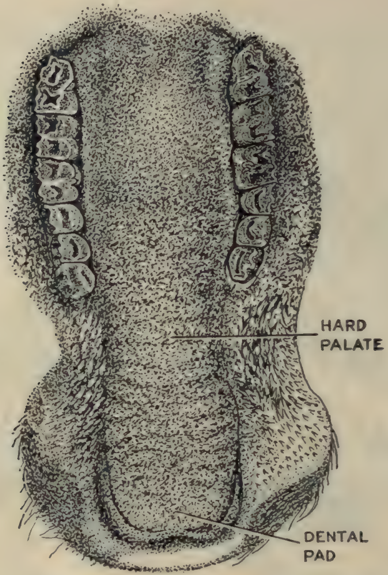

FIGURE 19.—Hard palate of an ox showing dental pad (from Sisson).

In the calf at birth two or more of the temporary or first set of incisor teeth are present. Within the first month the entire eight incisors have appeared (fig. 20).

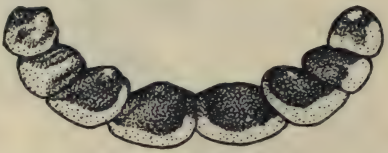

FIGURE 20.—Internal face of incisors of the calf at 1 month.

As the animal approaches 2 years of age the central pair of temporary incisor teeth or pinchers is replaced by the permanent pinchers. At 2 years these teeth attain full development (fig. 21).

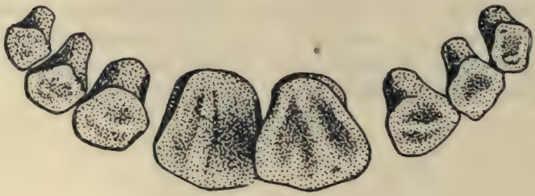

FIGURE 21.—Internal face of incisors at 2 years.

At about 2½ years the permanent first intermediates, one on each side of the pinchers, are cut and are usually fully developed at 3 years (fig. 22).

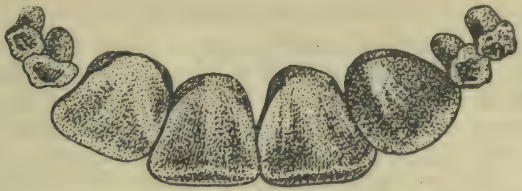

FIGURE 22.—Internal face of incisors at 3 years.

At 3½ years the second intermediates or laterals are cut. They are on a level with the first intermediates and begin to wear at 4 years (fig. 23).

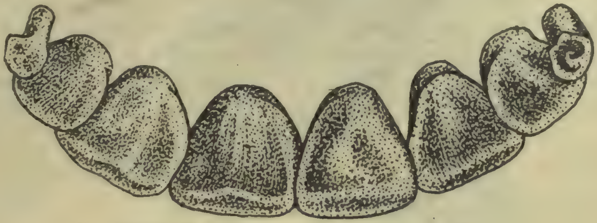

FIGURE 23.—Internal face of incisors at 4 years.

At about 4½ years the corner teeth are replaced. At 5 years the animal usually has the full complement of incisors with the corners fully developed (fig. 24).

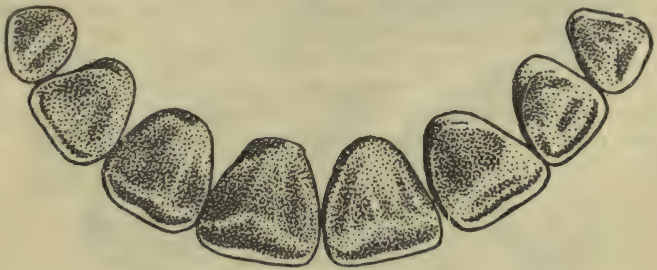

FIGURE 24.—Internal face of incisors at 5 years.

At 5 or 6 years there is a leveling of the permanent pinchers, the pinchers usually being leveled at 6 years and both pairs of intermediates partially leveled and the corner incisors showing wear.

At 7 or 8 years there is a noticeable wearing of the pinchers; at 8 or 9 years, of the middle pairs; and at 10 years, of the corner teeth.

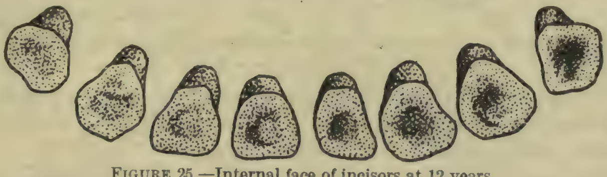

FIGURE 25.—Internal face of incisors at 12 years.

After the animal has passed its sixth year, the arch gradually loses its rounded contour and becomes nearly straight by the twelfth year (fig. 25). In the meantime the teeth have gradually become triangular in shape, distinctly separated, and show progressive wearing to stubs. This condition becomes more marked with increasing age.

SHEEP AND GOATS

Mature sheep and goats have 32 teeth, of which 24 are molars and 8 are incisors (fig. 26). There are no tusks and, like those of cattle, all the incisors are in the lower jaw. As in the case of cattle, also, the two central incisor teeth are called pinchers; the adjoining ones, first intermediates; the third pair, second intermediates; and the outer ones, corners. The temporary incisors are readily distinguished from the permanent ones by their smaller size and milky whiteness.

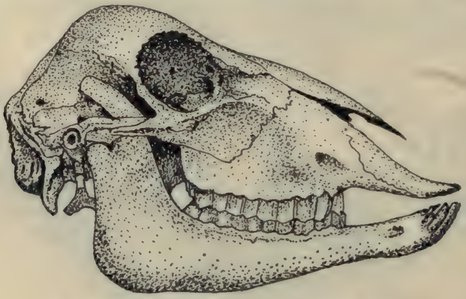

FIGURE 26.—Skull of a sheep (from Sisson).

In the new-born animal none of the teeth may have made their appearance though sometimes the two pinchers and also the two first intermediates are pressing through the gums or even have cut through. In a few days these teeth and the second intermediate incisors will appear, followed somewhat later by the corners, thus giving the animal, by the time it is 3 months old, a full set of completely developed temporary incisor teeth, as shown in figure 27, *A*.

When the animal is between 12 and 15 months of age the temporary pinchers are replaced by the two permanent ones (fig. 27, *B*).

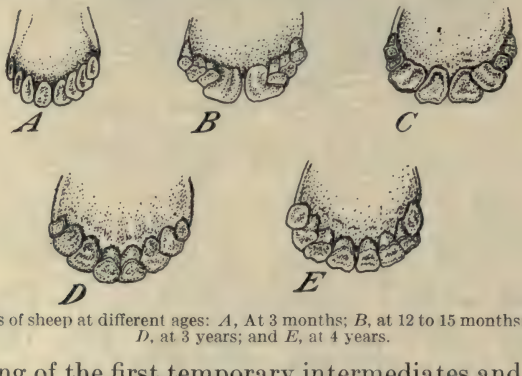

FIGURE 27.—Incisors of sheep at different ages: *A*, At 3 months; *B*, at 12 to 15 months; *C*, at nearly 2 years; *D*, at 3 years; and *E*, at 4 years.

The shedding of the first temporary intermediates and their replacement by permanent teeth indicate that the animal is approaching its second year (fig. 27, *C*).

The replacement of the second temporary intermediates by the permanent ones takes place when the animal is about 3 years old (fig. 27, *D*).

The two temporary corner incisors are replaced by permanent teeth as the sheep reaches the age of 4 years. All the permanent teeth are then present, and the animal has what is termed a "full mouth" (fig. 27, *E*).

After this time there is a distinct and progressive increase in size of the spaces between the teeth, which gradually become worn to stubs and frequently attain an unnatural and uneven length. In old sheep some teeth may be broken or loose; in such cases the animal is said to have a broken mouth.

SWINE

A mature hog has 44 teeth (fig. 28). Of these, 12 are front teeth or incisors, and 6 are in the upper and 6 in the lower jaw. Four others lie in the open spaces back of the incisors and are known as tusks, or tushes. They are usually more prominent in the male than in the female. Back of each tush is a tooth commonly called the premolar, and immediately back of this on each side of the upper and lower jaws there are 6 molars, the first 3 in each row sometimes being termed premolars. As in the horse, the incisors are grouped in three pairs in each jaw and are termed centrals, intermediates, and corners in accordance with their relative positions.

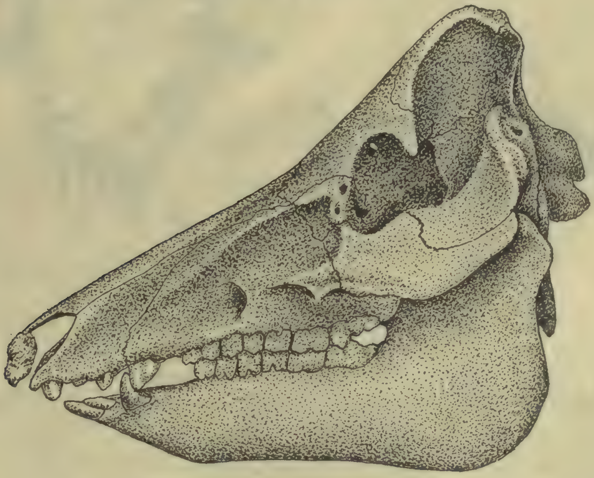

FIGURE 28.—Skull of a hog (from Sisson).

The young pig at birth usually has 8 teeth. These consist of the 2 tusks and 2 corner incisors on each jaw. They are all sharply pointed and are sometimes known as needle teeth (fig. 29, *A*). It is a common practice to cut them off, about halfway between the gum and point of the tooth, in the new-born pig, in order to avoid discomfort and injury to the nursing sow.

When the pig reaches the age of 4 or 5 weeks the central temporary incisors appear, two in the upper and two in the lower jaw (fig. 29, *B*).

As the animal approaches the age of 6 to 8 weeks the two intermediate incisors will have cut through the gums of the lower jaw between the corners and the centrals and will be fully grown at 3 months (fig. 29, *C*).

As the pig passes 6 months of age the temporary corner incisors are shed, and the permanent corners appear. Shortly after 9 months the permanent tusks take the place of the temporary tusks. At approximately 12 months the central permanent incisors replace the temporary centrals, and the lower teeth appear as shown in figure 29, *D*.

During the next 3 months the first 3 temporary molars, on each side of upper and lower jaw, will be shed. These are immediately back of the premolars, which in turn are back of the tusks. When these temporary molars, 12 in all, have been replaced by permanent molars, the pig has attained the age of at least 15 months.

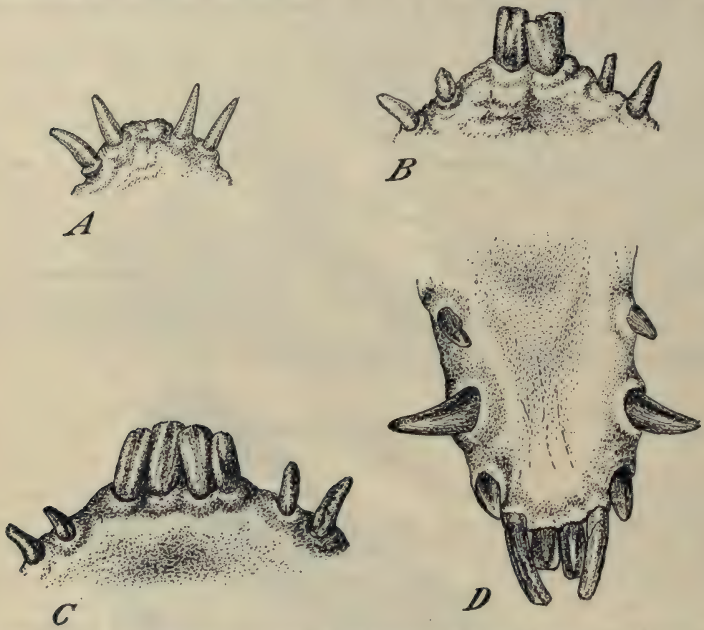

FIGURE 29.—Teeth in the lower jaw of the hog: *A*, At birth; *B*, at about 5 weeks; *C*, at 3 months; and *D*, at 12 months.

As a rule the shedding of the temporary intermediate incisors and the appearance in their places of the permanent ones are indications that the hog is approximately 18 months of age. By the time the animal has reached the age of 20 months these intermediate incisors will be in line with the centrals (fig. 30).

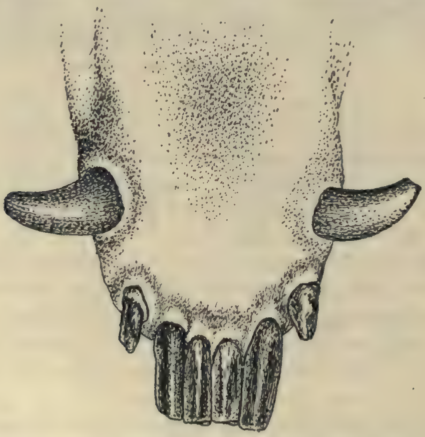

FIGURE 30.—Lower front teeth of a hog approximately 20 months old. The prominent tusks indicate that the animal is a boar.

As there is no further shedding or eruption of teeth, the age of hogs beyond 20 months of age cannot be so easily estimated. At 2 years, however, the incisors, including the intermediates, will show wear, and the sixth or last molars (one upper and one lower on each side) will be fully up and about to come in contact.

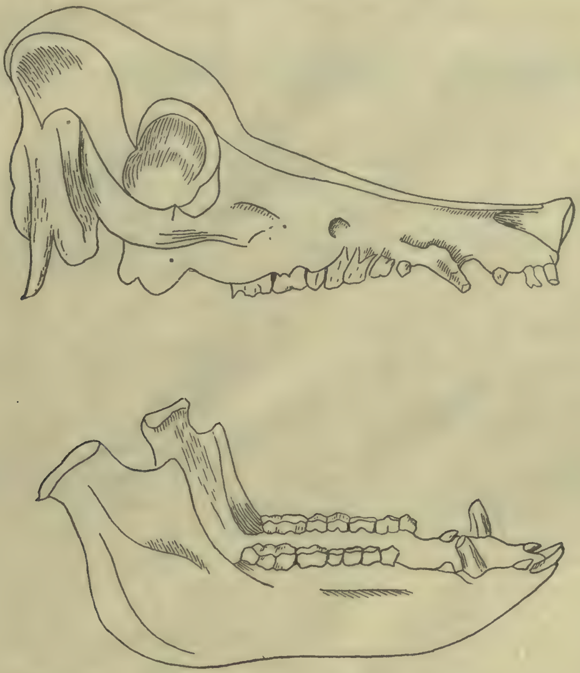

FIGURE 31.—Typical appearance of teeth of an 8-year-old sow

After 2 years it is difficult to judge the age of swine by the teeth. However, except in the case of breeding and exhibition animals, it is not often important to know the exact age of mature hogs. It is possible, however, to associate progressive wear of the teeth with the advance in age. Aged swine show considerable wear of the teeth, especially of the molars (fig. 31).

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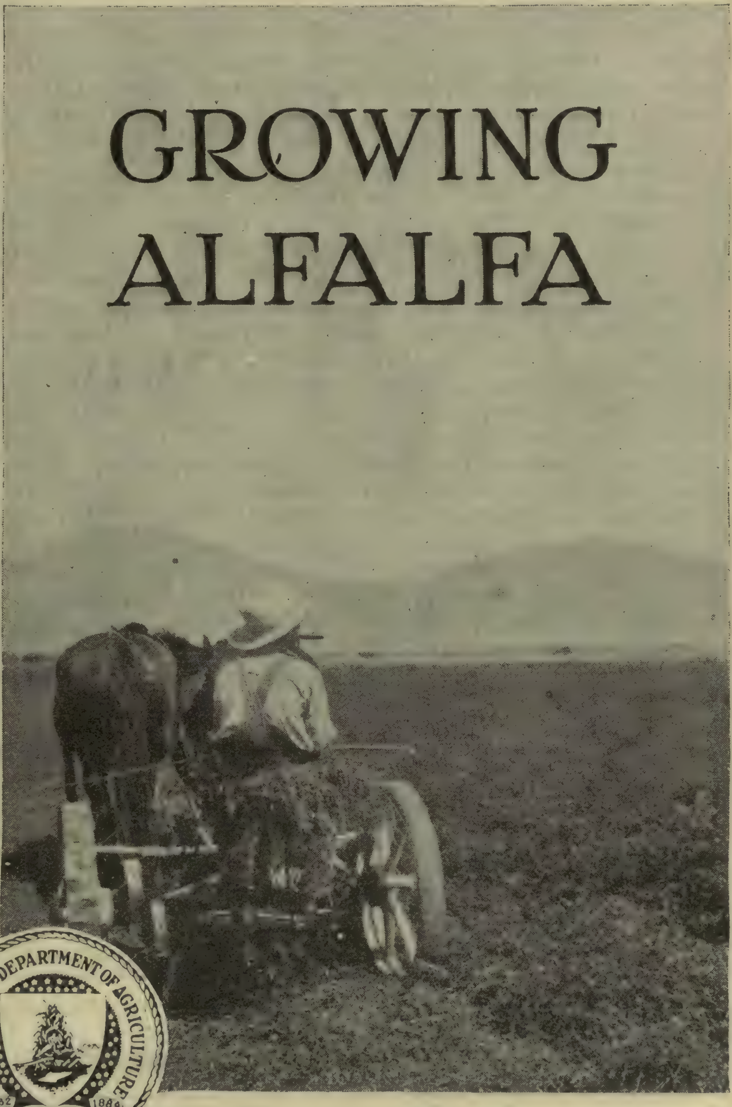
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1722

GROWING ALFALFA



ALFALFA is a perennial legume belonging to the same family as peas, beans, and clover.

The leading commercial varieties of alfalfa in the United States are the Common, Grimm, and Peruvian. Grimm alfalfa is superior to the Common in the North, and less hardy varieties are preferable for the South.

Alfalfa succeeds best in a dry climate where water is available for irrigation. The best soils on the farm should be selected for the alfalfa field. It is practically useless to attempt to grow the crop on nonproductive lands to improve them.

It is best to precede alfalfa for a year or two with some cultivated crop, such as corn, potatoes, or cotton, to free the land from weeds. The ideal seed bed is a well-settled subsurface with a fine surface that is loose to a depth of 2 inches.

Alfalfa should be sown early enough to permit the plants to become well established before winter sets in. The rate of sowing depends upon the condition of the soil. In the East 15 to 20 pounds per acre is generally advised. In the West, under irrigation, 15 pounds is sufficient, while under dry-land conditions 8 to 10 pounds is ample. Except under very favorable conditions alfalfa should be sown without a nurse crop.

Except where alfalfa is grown under irrigation there is little to be gained by harrowing broadcast fields so long as the stand is satisfactory and the plants are making a good growth. Attempts to thicken up thin stands by resowing or other means nearly always result in failure.

Stands are maintained longer and the yields are generally larger where cutting is delayed until the plants are well in bloom. Hay of a higher feeding value is obtained from cuttings made at the bud or early bloom stage.

Alfalfa hay and pasture are readily eaten by all classes of farm animals.

Alfalfa produces seed in paying quantities only when the rainfall is comparatively light. The average yield per acre runs from 2 to 4 bushels.

This bulletin is a revision of and supersedes Farmers' Bulletin 1283, How to Grow Alfalfa.

Washington, D.C. Issued March 1934

GROWING ALFALFA

By H. L. **Westover**, *senior agronomist, Division of Forage Crops and Diseases, Bureau of Plant Industry*

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INTRODUCTION

ALFALFA (*Medicago sativa* L.) is a herbaceous perennial legume belonging to the same family as peas, beans, and clover (fig. 1). Its flowers are borne in loose bunches, or racemes, and are of a purplish color. The pods in which the seed is produced are twisted spirally in one or two turns, similar to the shell of a snail. Each pod contains several small kidney-shaped seeds. The stems, which are usually not more than one eighth of an inch in diameter, are erect and commonly reach a height of 2½ feet. They arise from a semiwoody base known as the crown. The root system is characterized by a distinct taproot, which in permeable soil extends to a considerable depth. The taproot has few to many branch roots. The leaves are in threes, like clover, and are arranged alternately on the stem.

It is generally believed that alfalfa originated in southwestern Asia, though forms from which it might have sprung are found in China and Siberia. Historical accounts indicate that it was first cultivated in Persia. From there it was taken to the Mediterranean countries and finally to North America. The first recorded attempt to grow alfalfa in the United States was made in Georgia in 1736, but it was not until about 1850, when alfalfa was taken to California from Chile, that its rapid extension began in this country.

ACREAGE

Alfalfa is one of the most important forage crops in the United States, exceeding in acreage any of the other perennial crops grown for this purpose with the exception of timothy alone or mixed with red clover.

Its culture has extended very rapidly since it was first grown successfully in the West. According to the United States census reports the acreage devoted to it practically doubled each 10 years between 1899, when there were 2,094,011 acres, and 1919, when this crop occupied 8,624,811 acres. In 1929 the area in alfalfa amounted to 11,515,811 acres, which represents an increase of 33.5 percent over the 1919 acreage.

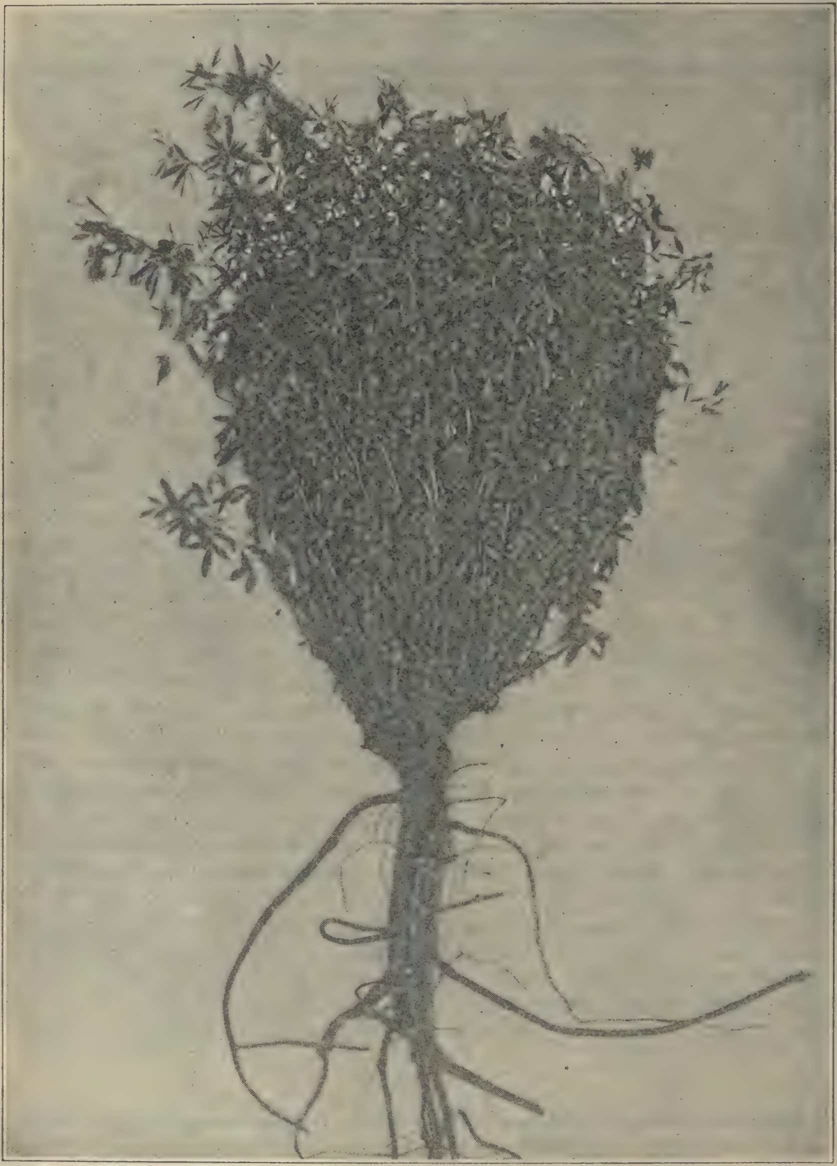

FIGURE 1.—A typical alfalfa plant.

By far the greater part of the alfalfa acreage is west of the Mississippi River although the proportion east of the river increased from about 1 percent in 1899 to a little more than 17 percent in 1929. Although the acreage south of the Kentucky-Tennessee line increased somewhat, the decided increase in acreage north of that line is largely responsible for the percentage of increase east of the Mississippi River. The actual increase in acreage east of the river between 1919 and 1929 was only about 340,000 acres less than the increase west of the river. This condition was probably the result in part of the spread of the bacterial wilt in the West and in part of the high freight rates which increased the price of hay in the East to such an extent that more attention has been given to local production. Nebraska led in acreage in alfalfa in 1929. Other States in order of acreage included South Dakota, Colorado, California, Idaho, Montana, and Kansas, all with well over half a million acres. Kansas dropped from first to seventh place during the period 1919 to 1929. The total production of alfalfa hay for the United States in 1929 was 23,493,505 tons, the average acre yield being slightly more than 2 tons. This ranged for the different States from a little more than 1 ton to about 3½ tons per acre. In general, the highest average yields were obtained in States where most of the crop was grown under irrigation. California led with an average yield of 3½ tons per acre.

VARIETIES

The commercial varieties of alfalfa in the United States consist of the regional strains of common alfalfa; the variegated group, including the varieties Grimm, Cossack, Baltic, Canadian Variegated (also known as Ontario Variegated), Hardigan, and Ladak; the Turkistan group, including commercial Turkistan and Hardistan; and the nonhardy Peruvian alfalfas.

Common alfalfa includes the greater part of the alfalfa grown in this country. Much of it traces originally to seed that was brought to California from Chile about 1850, and for this reason is frequently referred to in Arizona and California as Chilean alfalfa. The seed from the various States or sections is usually designated by the name of the State in which it is grown. Common alfalfa varies considerably in hardiness and other characteristics, depending upon the conditions under which it has been produced. Where it has been grown for several seed generations in the North it has acquired characteristics which render it more resistant to winter-killing than where it is grown southward. In purchasing seed, therefore, an effort should be made to procure it from a source where the winters approximate in severity those where the seed is to be sown. In the southeastern one fourth of the United States, seed of common alfalfa grown in Kansas and at similar latitudes generally has given larger yields of hay and for this reason is usually more desirable than seed produced in the Northern States.

The alfalfas of the variegated group are generally recognized as being hardier than the common alfalfas. They are the result of a natural cross between the well-known purple-flowered alfalfa (*Medicago sativa*) and the yellow-flowered species (*M. falcata*). They owe their superior hardiness in part to the presence of the yellow-flower blood in their ancestry and in part to the natural selection that has taken place under the severe climatic conditions to which they have been subjected. The variegated alfalfas are recommended for the Northern States, where the winters are severe. Southward, where winter-killing is not a factor to be considered, certain strains of common alfalfa will ordinarily give somewhat larger yields, and the seed is usually cheaper.

Grimm alfalfa is the best known and most extensively grown variety in the variegated group. It was brought to this country from Germany in 1857 by Wendelin Grimm and was grown for several years in Minnesota before the attention of the public was called to its superior hardiness. Owing to its cold-resistance, its culture is confined pretty largely to the northern half of the United States, where the winters are severe.

Cossack alfalfa was introduced into the United States from Russia through the efforts of the United States Department of Agriculture in 1907. In tests this variety has given results comparable to Grimm alfalfa, but it is grown on a much smaller scale.

Baltic alfalfa takes its name from Baltic, S.Dak., near which town it was grown for several years. In yield and adaptability this variety compares favorably with Grimm but has not given evidence of being superior. It has not been extensively grown, and the seed supply is rather limited.

Canadian Variegated alfalfa is quite similar in appearance and adaptation to Grimm alfalfa. In the northern humid States it has given results comparable to Grimm, but in tests in the northern Great Plains it has not appeared quite so hardy nor as productive. Practically all of the seed sown in the United States is produced in Canada. Under regulations promulgated in pursuance of the Federal Seed Act, 1 percent of each lot or shipment must be stained violet before it is permitted entry into this country.

Hardigan alfalfa is a selection from Baltic made by the Michigan Agricultural Experiment Station for superior hay and seed production. In numerous tests in various parts of the United States it has compared favorably with the other variegated alfalfas but has shown no evidence of being materially superior in cold resistance and productivity.

Ladak alfalfa was imported through the efforts of the United States Department of Agriculture from northern India in 1910. It has given excellent results in the northern Great Plains. It is hardier and more drought-resistant than other alfalfas of the variegated group and has the further advantage of being somewhat resistant to the bacterial wilt.

Turkistan alfalfa was introduced into the United States in 1898, and at one time most of the imported seed came from Turkistan. In recent years, however, comparatively little Turkistan seed has reached this country. Turkistan alfalfas vary in their reaction to cold and bacterial wilt, but recent tests indicate that seed from the most important seed-producing districts in that country is generally equal or superior to Grimm alfalfa in hardiness and is also resistant to bacterial wilt. In numerous tests in various parts of the United States Turkistan alfalfa has usually been less productive than some of our domestic alfalfas. It has given fairly good results in the central and northern Great Plains and may be used to advantage in that area where wilt is prevalent, especially if the grower desires to retain the stands several years.

In the East and South, however, Turkistan alfalfa has given very unsatisfactory results owing to its tendency to become dormant early in the fall and to its susceptibility to yellowing and to certain leaf diseases which result in the shedding of many of the leaves before the alfalfa has reached the most desirable stage for harvesting. Under regulations governing the enforcement of the Federal Seed Act, 10 percent of Turkistan alfalfa seed must be stained purple-red before it is permitted entry.

Hardistan is the name given by the Nebraska College of Agriculture to an alfalfa which is undoubtedly of Turkistan origin and which first attracted attention by its apparent resistance to wilt and cold. It is very similar to some of the better commercial importations from Turkistan as regards resistance to cold and wilt, susceptibility to leaf diseases, tendency to early dormancy, and productivity. While the variety is promising where wilt is prevalent in the upper Mississippi and Missouri Valleys, preliminary tests indicate that it is not likely to prove more satisfactory in the East and South than most of the commercial lots from Turkistan. The seed supply is at present very limited, but efforts are being made to increase the seed for sowing in areas where wilt is destructive.

Kaw alfalfa, recently so named by the Kansas Agricultural Experiment Station, is undoubtedly of Turkistan origin and behaves in all respects like other alfalfas from that source. It is not likely to be of any particular value in the East or South. Seed is not yet commercially available, though efforts are being made to increase the supply.

Peruvian alfalfa is the least hardy and most rapid growing of our commercial varieties. It was introduced into the United States from Peru in 1899. It seldom survives the winters where the temperature falls below 10° F. and is therefore suited only to the extreme South and Southwest. Where it survives the winters, Peruvian alfalfa gives somewhat larger yields than most other varieties. Two strains of Peruvian alfalfa are recognized, the smooth-leaved Peruvian and the hairy Peruvian. The latter usually produces somewhat heavier yields of hay than the former and is therefore preferable. A more detailed discussion of these alfalfas, as well as of others of less importance, will be found in Farmers' Bulletin 1731, entitled "Alfalfa Varieties in the United States."

SEED

Before buying alfalfa seed there are three points upon which the purchaser should have information: (1) The name of the variety, (2) the section of the country in which it was produced, and (3) the quality of the seed with regard to germination and purity. Unfortunately, it is not possible to distinguish between varieties or strains of alfalfa by the appearance of the seed, and at times, owing to misrepresentation, intentional or otherwise, farmers have had more or less difficulty in obtaining seed of the kind of alfalfa desired. This situation, however, has been remedied to a considerable extent, and now by observing proper precautions the grower may be reasonably sure of the variety and origin of the seed he purchases.

Several State agencies register and certify alfalfa seed as to variety, each package bearing a tag to this effect. Varieties so registered and certified include Grimm, Baltic, Cossack, Ladak, Hardigan, and in some States seed from fields of common alfalfa of long standing. The United States Verification Service verifies the origin or place where the seed was grown without regard to the variety, and each package of such seed bears the United States verification tag.

An amendment to the Federal Seed Act requires that certain percentages of all lots of imported seed be stained before it is permitted to enter the United States, the color depending upon the adaptability of the seed as determined by tests conducted in this country. Seed from Canada has been found suitable for growing in the United States; 1 percent of it is stained violet. Ten percent of seed from Africa is stained red, as it is not adapted. Ten percent of seed from Turkistan is stained purple-red, and 10 percent of that from South America orange-red, indicating that such seed is of value in restricted areas. Ten percent of imported seed of unknown origin is stained red, while 1 percent of foreign seed of known origin, the adaptability of which has not as yet been determined, is stained green.

The viability of the seed, or its ability to germinate, is quite clearly indicated in its appearance. Plump seeds of a bright olive-green color almost invariably germinate well, while shriveled seeds or seeds that are of a brownish color usually germinate poorly. Alfalfa seed turns reddish brown with age, and while some viable seed may possess this color, such seed should not be purchased without a germination test, even if it is offered at a price materially less than that asked for seed of a fresh olive-green color. When a germination test is desired it can be made by placing 100 seeds between cloths or blotting paper and keeping them moist and at a temperature of about 70° F. After 5 or 6 days most of the readily viable seeds will have sprouted. There will be some, however, that will remain hard, especially if they are of the variegated varieties. Many of these hard seeds will grow when put in the ground, and therefore they should be considered in estimating the percentage of germination. The Department of Agriculture, through its main seed laboratory and branch laboratories, is prepared to make a limited number of germination tests free of charge, but in order to prevent delay beyond the seeding time samples should be mailed to the Department at least 2 months in advance.

With regard to the purity of alfalfa seed, every farmer should be able to recognize readily the most important weed seeds and other impurities that are commonly found in it. Seed to be acceptable should contain not more than 2 percent of impurities. At the present time there is almost no attempt to adulterate alfalfa seed in this country, but every lot should be carefully examined for seed of noxious weeds, especially dodder, before it is purchased. The seeds of dodder are smaller than those of alfalfa, more nearly round, and have a pitted surface which can be detected only by the aid of a lens. As dodder is a troublesome weed and its seed cannot readily be separated from alfalfa seed, dodder-free seed should be demanded by the purchaser. Seeds of buckhorn should always be looked for when samples of alfalfa seed are examined before purchasing. These seeds are shiny brown in appearance, boat shaped, and about twice the length of the alfalfa seed. Seeds of Russian knapweed should also be searched for carefully, as their presence indicates seed of the imported Turkistan variety. Russian knapweed is now occasionally found in some localities producing alfalfa seed in the United States, and its seed is likely to be found in domestic-grown alfalfa seed. While the Division of Seed Investigations, Bureau of Plant Industry Department of Agriculture, is prepared to make a purity analysis of a limited number of samples free of charge for private individuals, it is very desirable that every farmer acquaint himself with the impurities and noxious-weed seeds that alfalfa seed commonly contains, in order that there may be no serious delay in purchasing seed for sowing.

CLIMATIC AND SOIL RELATIONS

The wide distribution of alfalfa in the world indicates a remarkable adaptability to climate and soil. While the crop requires considerable moisture to produce profitable yields of hay or pasture, it does best in a relatively dry atmosphere where water is available for irrigation. It is not as well adapted to humid conditions. In the United States it succeeds at altitudes ranging from below sea level in the Imperial Valley, Calif., to 8,000 feet in the mountains of Colorado. It withstands hot weather well but is seriously affected by the cold weather of winter and early spring. To what extent extremely low temperatures alone are responsible for the death of alfalfa plants during the winter is not known, but this, together with other winter conditions, commonly results in high mortality. On poorly drained clay soils alternate freezing and thawing, such as occur in many sections, frequently do much damage to alfalfa by heaving the plants out of the soil and incidentally breaking the roots 6 or more inches from the crown.

Deep loam with open porous subsoils are undoubtedly best for alfalfa, but where other conditions are favorable the plant has a very wide range of adaptation insofar as soils are concerned. On account of the deep, penetrating character of its root system alfalfa does not thrive on a soil that has an impervious subsoil, hardpan, or bedrock near the surface. Instances have been observed, however, where it made satisfactory growth on soils underlain at 18 inches by limestone ledges.

Good surface drainage and underdrainage are both necessary if alfalfa is to thrive. During the growing season complete submergence for 24 or 48 hours may do considerable injury, but when the plants are dormant they may remain under water several days with no serious damage. The formation of ice sheets on alfalfa fields during the winter months may result disastrously. It is sometimes possible to reduce the amount of damage to a minimum by breaking up the ice sheets with a disk or in a similar manner. Alfalfa seldom succeeds where the water table comes close to the surface, especially if the level of the water table fluctuates considerably.

In the eastern part of the United States rich river bottoms and soils of limestone origin are best suited to alfalfa, provided they are well-drained. There, where the climatic conditions are not generally favorable, only the best soils available should be devoted to the crop. On strongly alkali soils, such as are frequently found in the West, alfalfa makes little or no growth.

CHOOSING A FIELD FOR ALFALFA

In selecting land for alfalfa careful consideration should be given to the texture of the soil, its productivity, and drainage. Where possible, very sandy or very compact soils should be avoided. The character of the subsoil requires special attention. It is a waste of time and money to attempt to grow alfalfa on land that is underlain at shallow depths by hardpan or other impervious strata. The soil auger is of considerable assistance in determining the character of the soil and subsoil and should be used freely.

The most productive soils on the farm should be selected for alfalfa. It is practically useless to attempt to grow the crop on lands that are nonproductive with the idea of building them up, as is often done. Where good drainage does not exist naturally, it must be supplied by artificial means before alfalfa can be expected to succeed. Tile drains placed 3 feet below the surface will ordinarily lower the water table sufficiently to insure the satisfactory growth of alfalfa, other conditions being favorable. Complaints are occasionally received of tile drains being clogged by alfalfa roots, but this occurs so seldom that it need be given little consideration.

PREPARATION FOR ALFALFA

THE PRECEDING CROP

Alfalfa may be successfully grown after almost any crop provided proper attention is given to the preparation of the soil after the preceding crop has been removed. In deciding upon the preceding crop, however, one should be chosen that fits best into the particular system of farming and at the same time leaves the land in good condition for alfalfa. Due consideration also should be given to the time available for preparing the seed bed for alfalfa after the preceding crop has been harvested. As the young alfalfa plants are very tender and are likely to be killed by weeds during their early stages of growth, it is best to precede the alfalfa for 1 or 2 years with some cultivated crop. Corn or potatoes in the North and corn, tobacco, or cotton in the South serve this purpose admirably. In the Southern States crimson clover or rye and vetch may be sown after the removal of any one of these cultivated crops. The cover crop should be plowed under or cut for hay the following season and the land prepared for alfalfa. Where late summer or early fall sowing is practiced, canning peas, early potatoes, and early sweet corn leave the land in excellent shape, and little further preparation is required. The heavy application of fertilizers which these crops require in many parts of the country will usually suffice for alfalfa. Except in the extreme North small-grain stubble may usually be worked up in time for late summer sowing provided the land has previously been treated so as to destroy the weeds. The chief objection to such a practice is the possible lack of moisture in the soil, due to the demands of the grain crop and the hot weather of summer. Crops that smother the weeds, such as cowpeas, may be used to precede alfalfa to good advantage. In the East it is not usually advisable to sow alfalfa on sod land, but in the Great Plains area this is done with a considerable degree of success.

PREPARING THE SEED BED

The tender nature of the young alfalfa plants requires that the soil be in excellent tilth at sowing time. Many of the failures to secure a good stand may be traced directly to a poorly prepared seed bed. A desirable condition is a well-settled subsurface and a fine surface that is loose to a depth of at least 2 inches. Such a condition is best obtained by plowing the land in the fall, disking in the spring, and harrowing occasionally to keep down the weeds until sowing time. Where fall-plowing is not practicable the land should be broken at least several weeks in advance of sowing. Meantime the soil should be disked and harrowed at frequent intervals to settle the seed bed. The cultipacker will be of considerable assistance in getting the soil into the desired condition. In the northeastern one fourth of the United States, where alfalfa is sown the same season after the removal of a crop of small grain, it is generally better to avoid plowing except on the heavier soils, as there is seldom sufficient time for the soil to become properly settled before sowing. If such land is well-prepared for the grain crop, a thorough disking followed by one or two harrowings will ordinarily leave the seed bed in fairly good condition. Land that has been in early potatoes, peas, or sweet corn can usually be prepared satisfactorily by removing the vines or cornstalks and harrowing. In preparing clover sod for alfalfa the land should be plowed as soon as the crop is removed and disked and harrowed until a firm fine seed bed is obtained. The preparation of sod land may be facilitated by cutting the sod with a disk before plowing. In semiarid regions summer-fallowing is often practiced to insure satisfactory moisture conditions for the seedlings the following spring. This method is also effective in any section for ridding the ground of weeds, but it involves considerable expense.

LIMING

No other of our commonly grown forage crops requires so much lime as does alfalfa. It is necessary not only to have enough to neutralize the soil but also an excess for the actual use of the plant. If there is any doubt about the need for lime, the question should be definitely settled before time and money are wasted in an effort to get alfalfa started. Litmus paper, which can be obtained at any drug store, is a simple though not always an infallible test of the need for lime. Since the lime requirements of soils vary so widely, the prospective grower of alfalfa would do well to seek more exact advice on the probable need for lime from his county agricultural agent or State agricultural experiment station.

In the humid East it is safe to assume that all soils except those of limestone origin will require lime for alfalfa. Even limestone soils are often acid at the surface, and lime must be applied before alfalfa will succeed on them. Limestone soils that do not require additional lime occur in the black belt of Alabama and Mississippi and near Syracuse, N.Y., while limestone soils that need lime are found in the Shenandoah Valley. With the exception of the soils of the Pacific slope of the northwestern part of the United States, which have a high lime requirement, most of the soils west of the ninety-fifth meridian do not require liming for alfalfa.

There are several different forms of lime on the market, such as burned lime, slaked or hydrated lime, ground limestone, oyster shells, and marls. Experiments have shown little difference in the final results from the use of different forms of lime provided an equal quantity of calcium oxide was supplied. Burned or hydrated lime may give quicker results, but ground limestone will eventually bring the same benefit. For correcting acidity, 1 ton of burned lime is equivalent to 1½ tons of slaked lime or 2 tons of ground limestone. Marls vary so in composition that a chemical analysis of the material from each source is necessary to determine the percentage of calcium oxide.

The quantity of lime required depends upon the soil, but ordinarily is not less than 1 ton of burned lime or the equivalent of this in other forms of lime. In some cases much larger quantities are required.

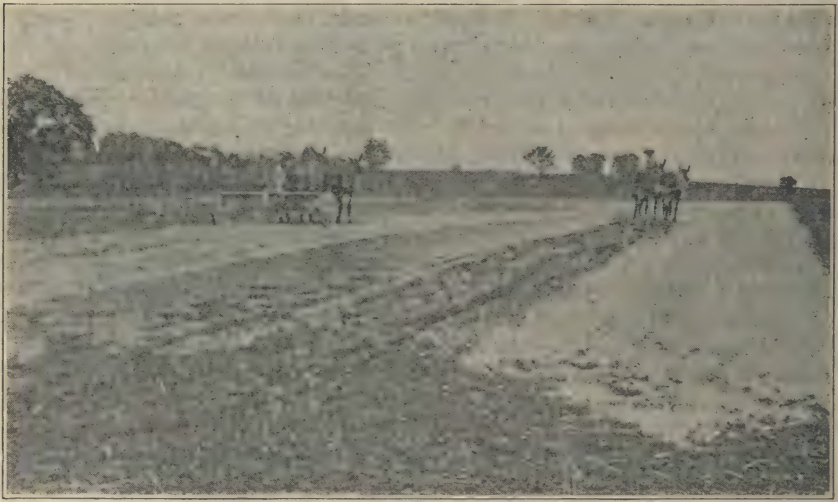

FIGURE 2.—Liming for alfalfa.

The farmer should use whichever is cheapest, based upon the relative proportion of calcium oxide, which is the essential element so far as correcting acidity is concerned. Where the consumer pays the freight he should bear in mind that he not only will have to pay such charges on twice as much ground limestone as on burned lime but also will have the additional expense of hauling and spreading 2 tons of the former to 1 of the latter to get the same benefit.

Where practicable it is well to apply part of the lime the season previous to sowing the alfalfa. This is particularly advisable where ground limestone or oyster shells are used, as the lime in this form is not so readily available as is the burned lime. Where it is not convenient to apply any part of the lime the preceding season, it may be applied after plowing, preferably 3 or 4 weeks before the seed is to be sown, and thoroughly incorporated with the soil. The lime may be applied with a manure spreader, a fertilizer distributor, a lime distributor, or by hand (fig. 2). Any method that spreads the lime evenly and at low cost is satisfactory. Top-dressing an alfalfa stand with lime is not recommended.

FERTILIZING

Alfalfa, being a heavy feeder, requires an abundance of available plant food in the soil for its best growth. In addition to this there should be a liberal supply of humus for the proper development of the nitrifying organisms, without which the crop will in many cases be a failure. On most of the soils east of the ninety-fifth meridian alfalfa responds to some sort of fertilizer treatment. The greatest need seems to be for phosphoric acid and humus, or decaying vegetable matter, and liberal applications of both will in most cases yield profitable returns.

Potash is an essential element, and light applications are beneficial on some clay soils and most sandy soils. Alfalfa requires some nitrogen in the soil for its early growth, but after it is once established, other conditions being favorable, it is able to procure most of its supply from the air by means of the bacteria in the nodules on the roots.

Good barnyard manure furnishes not only humus but also other plant food required by alfalfa and for this reason is one of the most satisfactory fertilizers. It may be applied to the previous crop; it may be applied in the autumn and plowed under prior to sowing alfalfa; or it may be turned under in the spring where fall-plowing is not practicable. It is always well to apply the manure long enough in advance so that it will become well incorporated with the soil. Where the quantity of barnyard manure is limited it may be made to go further by using some superphosphate (acid phosphate) in connection with it. Where it is not available the humus may be supplied by plowing under some green-manure crop and by applying commercial fertilizers. In the North such crops as rye, vetch, and Canada field peas may be used. Farther south bur clover, crimson clover, soybeans, and cowpeas answer the purpose admirably.

If commercial fertilizers are used they should consist largely of superphosphate, about 300 to 500 pounds per acre of 16 percent superphosphate, about 50 to 75 pounds of nitrate of soda to give the alfalfa a start, and 75 to 100 pounds of muriate of potash. The proportion of potash may be increased on sandy soils and decreased or eliminated entirely on clay soils.

Other forms of fertilizer may be used to supply the elements needed by alfalfa, such as cottonseed meal in the place of nitrate of soda and other materials which furnish phosphoric acid. Generally speaking, raw rock phosphate has not given as satisfactory results as superphosphate, since it is much slower in acting than after it has been treated with acid. Most of the experiments that have been conducted in the East indicate that alfalfa is not appreciably benefited by applications of flowers of sulphur.

West of the ninety-fifth meridian many of the soils do not require any special fertilizer treatment for alfalfa. However, there seem to be an increasing number of cases where land that has given good yields of alfalfa for several years when reseeded failed for some reason to give satisfactory results, indicating a decrease in certain plant-food elements. In such cases the use of superphosphate has often proved highly beneficial. On some of the lands of the Pacific Northwest, particularly in Oregon, applications of 50 to 100 pounds per acre of flowers of sulphur have given greatly increased yields.

On the same soils gypsum has increased the yields of alfalfa. In many cases, however, these fertilizers, if they produce any increase in the growth of alfalfa, do not give sufficient increase to justify the extra labor and money involved, and the farmer is advised to avoid any great expense in connection with their use until he has first determined on a small scale whether they will produce any appreciable benefit.

INOCULATION

With the exception of those of the Pacific-coast region of the northwestern part of the United States, most of the soils west of the ninety-fifth meridian are naturally supplied with proper bacteria for inoculating alfalfa. In the eastern part of the country, however, where the soil conditions are less favorable to the growth of nitrogen-fixing bacteria, it is nearly always necessary to supply them at the time of sowing, where alfalfa is grown for the first time. Fields that within the past few years have grown alfalfa, sweetclover, bur clover, or black medic successfully will not ordinarily need further inoculation for alfalfa.

The surest way of getting a new stand of alfalfa well inoculated is to scatter soil from a successful alfalfa field or from the roots of sweetclover or bur-clover plants. In the past the general recommendation has been to use 250 to 500 pounds of soil per acre, the application of which is rather tedious and expensive. In some experiments equal quantities of soil and seed have given good results. This mixture may be sown broadcast or drilled. Where it is drilled in, only finely sifted soil should be used, and as the soil particles are inclined to work toward the bottom of the drill box it may be necessary to add a little occasionally or keep the seed well stirred. Moistening the seed with water to which has been added a little glue and mixing a small quantity of soil with the seed, although not always successful, has in many cases resulted in satisfactory inoculation.

Inoculation is also accomplished by means of artificial cultures, which are put out by most of the State agricultural experiment stations and several commercial firms. Instructions for use accompany these cultures.

The practice of sowing a small quantity of alfalfa with the regular sowing of clover or other hay-crop seed has in some cases apparently been the means of introducing sufficient bacteria for inoculating the succeeding crop of alfalfa.

Investigations indicate that a single inoculation should be adequate for many years, provided the soil is kept well supplied with organic matter and lime, even though alfalfa or sweetclover is not grown on the land. If the soil is allowed to become strongly acid or to lose a large part of its vegetable matter the bacteria decrease very rapidly.

SOWING ALFALFA

METHOD OF SOWING

The method of sowing varies considerably in different sections. It may be done with a grain drill with a seeder attachment or with an alfalfa drill (fig. 3), or the seed may be broadcast with a hand seeder, a wheelbarrow seeder, or by hand and covered with a light harrow, a weeder, or a brush drag. Where the seed is drilled a somewhat lighter rate is required than where it is broadcast, as better conditions are provided for germination. In order to insure a more even stand, it is best to sow half the seed one way across the field and the other half at right angles to the first sowing. The depth to which the seed should be covered depends on the character and condition of the soil. On heavy soil 1 inch is usually sufficient, but 1½ inches is preferable on sandy soils or on dry soils, to insure getting the seed in contact with moisture. The use of a cultipacker after sowing is of considerable assistance in making conditions favorable for the germination of the seed.

Good results are occasionally reported from broadcasting on honeycombed ground during late winter or early spring, but such a practice can be expected to succeed only under the most favorable conditions and cannot be recommended for general use. In most parts of the country it is necessary to cover alfalfa seed, and good results cannot be depended upon if it is left on the surface of the ground, as is sometimes done with grass and clover. In a few instances sowing in corn at the last cultivation has given good stands, and yet it can hardly be termed a safe practice. With abundant rainfall and ideal soil conditions this method sometimes gives good results. The presence of the stubble may be more or less troublesome in the first cutting the next season unless the corn is cut very close to the ground.

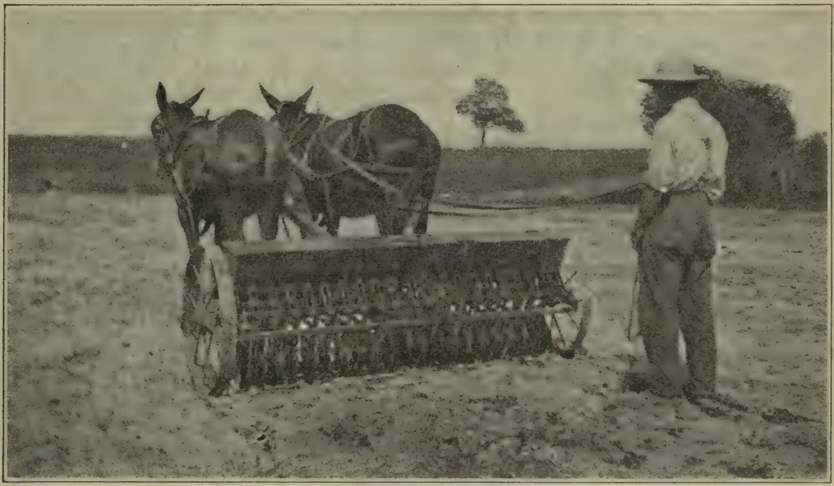

FIGURE 3.—An alfalfa drill.

TIME OF SOWING

The general principle underlying the time of sowing is to get the seed in the ground as far as possible in advance of what promises to be the most trying season for the young plants. In the northern half of the United States, where rainfall is abundant and soil conditions are suited to afalfa, seed is often sown in the early spring with a nurse crop. Where sown alone, late spring or early summer sowing is generally best, as this gives an opportunity for preparing a good seed bed and at the same time permits the plants to become thoroughly established before cold weather sets in. In the Southeast the most favorable time varies from the middle of August in the latitude of Washington to late October or early November along the Gulf coast. February and March sowings are sometimes successful in the extreme South, but late spring and early summer sowings are likely to be crowded out by the weeds.

In the northern part of the dry-farming area of the Great Plains it is almost necessary to sow the seed as early in the spring as the land can be put into shape, since moisture conditions are most favorable at that time. During the summer the soil usually is so dry that the young plants are not able to make sufficient growth to withstand the cold winters. In the southern part of this area, however, good stands are often obtained from late summer and early fall sowings.

In the irrigated districts of the Southwest, October is the best month for sowing alfalfa, although good stands are obtained almost any time between October 1 and April 15. The hot summer months constitute the most unfavorable period. In the North the spring sowings are most satisfactory, although good stands have been obtained where the seed was sown in grain stubble in the late summer or early fall.

RATE OF SOWING

A good stand of alfalfa is highly important from the outset. The quantity of seed necessary to insure a sufficient number of plants per acre varies with different parts of the country and is directly dependent upon the condition of the seed bed. If every seed should grow, 1 or 2 pounds per acre would be ample, but some of them are not viable and others are covered too deeply or else fall in dry soil and fail to germinate. Furthermore, many plants that start to grow succumb in the seedling stage, due to one cause or another. For these reasons it is always advisable to sow a larger quantity of seed than would be necessary under ideal conditions, particularly as the farmer seldom takes the time or goes to the expense of preparing an ideal seed bed. As the cost of the seed is a relatively small item, it is better to waste some by sowing more than is needed than to run the risk of a thin stand that offers a foothold for weeds. In the eastern humid States 20 pounds per acre is sufficient where land is properly prepared, though a heavier rate is sometimes recommended in the South. On most of the soils in the Great Lakes States and in the western part of the humid area 15 pounds of seed is ample. Under dry-farming conditions 8 to 10 pounds of seed is advised, although good stands are sometimes obtained with 4 or 5 pounds. Under irrigation the quantity of seed commonly recommended is 15 to 20 pounds. The heavier rate should be used wherever weeds are likely to be troublesome, as is the case in some parts of the Southwest. In the northern irrigated districts good stands are obtained with 15 pounds of seed.

ALFALFA IN MIXTURES

Because of its ability to produce two or more cuttings in a season alfalfa is not generally well suited to sowing in mixtures with grasses and clovers. Usually mixtures have not yielded much more than alfalfa alone but the presence of grass affords some protection against heaving. In humid districts where more or less difficulty is encountered in curing alfalfa the presence of some grasses may be of appreciable value in hastening the process, and, furthermore, some feeders prefer mixtures to alfalfa alone. Grasses are sometimes sown with alfalfa for pasturing to reduce the danger from bloat. Timothy is probably used in mixture with alfalfa more than any other grass because of its wide popularity. It is used to some extent in the East and to a considerable extent in parts of the Northwest where alfalfa is grown under irrigation. The mixture is also commonly sown at high altitudes. There are quite a number of farmers in the Northeast who make a regular practice of sowing a little timothy with alfalfa on the theory that when the alfalfa dies out the timothy will fill up the vacant spaces and check the growth of the weeds. Timothy, however, does not thicken its stand under meadow conditions. Orchard grass and meadow fescue are better suited for sowing with alfalfa than is timothy, as they mature more nearly with it.

In the northern Great Plains area, northwestern Missouri, and western Iowa smooth bromegrass gives fairly good results when sown with alfalfa. After a few years, however, the bromegrass forms such a dense sod that the surviving plants of alfalfa are unable to make a very vigorous growth in it. Kentucky bluegrass is not satisfactory, as it crowds out the alfalfa.

NURSE CROPS

Where a nurse crop can be used without danger of decreasing the chance of securing a stand of alfalfa, it is quite desirable, as it gives some return from the land while alfalfa is becoming established. The chief objections to a nurse crop are that it draws rather heavily on the moisture supply of the soil, and as it is harvested at a hot time of the year the sudden change from the shade offered by it to the bright sun is likely to prove injurious to the alfalfa seedlings.

The practice of making early spring seedings with any one of the small grains where conditions are favorable for alfalfa is becoming more general, and satisfactory stands usually result. The small grains are probably no harder on the alfalfa than the heavy growth of weeds which generally results in early seedings without a nurse crop. Any one of the spring grains, preferably an early maturing variety of flax, may be used as a nurse crop. Such evidence as is available indicates that in regions adapted to flax it is one of the safest nurse crops for alfalfa. It is generally advisable to sow the grain at about one half the normal rate and harvest it as soon as it shows evidence of injuring the alfalfa. Good results have also been reported from sowing alfalfa with winter wheat sown in the spring. In parts of the Northeast satisfactory stands are secured where alfalfa is sown with canning peas as they come off early and are less injurious to the young seedlings than are the small grains. Alfalfa is sometimes sown in the spring in winter wheat or rye, but the results from sowing in such an established crop are less likely to be satisfactory. Wheat or rye ground is often rather compact, and as alfalfa seed must be covered to insure a satisfactory stand, it is necessary to loosen the soil before drilling or broadcasting the alfalfa seed. In some cases it is advisable to follow with a harrow after seeding to insure better covering.

In the dry-farming regions, where moisture is the limiting factor, the use of a nurse crop is almost sure to prove disastrous except in seasons of abundant rainfall. Under irrigation the percentage of successful stands with a nurse crop runs somewhat higher. The practice is quite commonly advised in spring sowings in the northern irrigated districts, but farther south it is considered a better practice to sow the alfalfa alone. The nurse crop is seldom used with late summer or fall sown alfalfa, except occasionally in the Southwest.

GROWING ALFALFA IN ROWS

At one time it was believed that growing alfalfa in cultivated rows would be advantageous in regions of limited rainfall (fig. 4). It was hoped that in such regions it would be possible to produce satisfactory yields of hay and seed in this way. Farmers as well as investigators of the United States Department of Agriculture and several State experiment stations have given the method a thorough trial. The results of these tests indicate that where the rainfall is not sufficient to produce profitable yields of hay in broadcast or close-drilled fields it is likewise too dry for alfalfa in cultivated rows. Where the rainfall is very limited the yield from rows is somewhat greater than that from the close-drilled fields, but not enough larger to justify the extra expense involved. The cultivation necessary to keep down weeds adds considerably to the expense of growing the crop. Moreover, the hay is of a poorer quality, as it is dusty and contains many small clods of dirt.

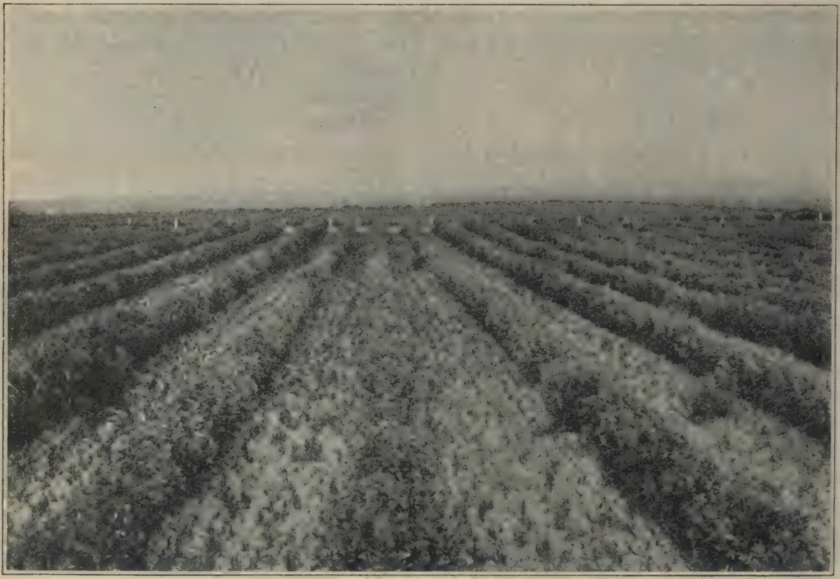

FIGURE 4.—Alfalfa in cultivated rows.

With a limited moisture supply alfalfa in rows ordinarily will give somewhat larger yields of seed than close-drilled or broadcast seedings, and under certain conditions this method appears to have possibilities particularly in the case of an unusual variety, seed of which commands a price sufficiently high to insure a profit in spite of low yields.

INSTRUCTIONS FOR GROWING ALFALFA, BY SECTIONS

MICHIGAN, WISCONSIN, MINNESOTA, NEW YORK, AND THE NEW ENGLAND STATES

In Michigan, Wisconsin, Minnesota, New York, and the New England States the following practices are observed in the growing of alfalfa.

Attention is given to the need for lime, fertilizer, and inoculation, as mentioned on pages 9–12. Land that is intended for alfalfa should be in some cultivated crop, such as corn or potatoes, for 1 or 2 years prior to being sown with alfalfa. The ideal seed bed is obtained by plowing in the fall and completing preparation in the spring. On some soils that have been in a clean-cultivated crop the previous season a good seed bed can be prepared by disking and harrowing in the spring without the necessity of fall plowing. Under favorable conditions good stands follow the practice of sowing the alfalfa seed in the spring with a small grain as a nurse crop. An early maturing variety of grain is preferable and should be sown at the rate of about 1 bushel per acre. In order to conserve moisture it is sometimes advisable to cut the grain for hay just after it has headed. If the grain lodges it should be removed early; otherwise it may smother the alfalfa. Canning peas make an excellent nurse crop, as they are harvested early.

Successful stands are also obtained from sowing the seed alone in June or early July, but when this is done no return is obtained from the land the first year. For this reason most farmers prefer to chance sowing later, after some other crop, such as an early crop of potatoes or early truck, has been removed, as the land requires little preparation for alfalfa provided the vegetable crop has been well cultivated. It is seldom safe to sow alfalfa after a crop of small grain has been removed, as there is barely time for it to become thoroughly established before cold weather, and the moisture supply may be limited, owing to the demands of the preceding crop. Seedings made later than the middle of August are not dependable, as the alfalfa may not make sufficient growth to withstand the winter.

On land that is well adapted to alfalfa 15 pounds per acre of clean seed that germinates 90 percent is sufficient. Under less favorable conditions 18 to 20 pounds per acre is safer.

OHIO, INDIANA, ILLINOIS, IOWA, MISSOURI, KENTUCKY, PENNSYLVANIA, NORTHERN NEW JERSEY, AND WEST VIRGINIA

On most of the soils in Ohio, Indiana, Illinois, Iowa, Missouri, Kentucky, Pennsylvania, northern New Jersey, and West Virginia, lime, inoculation, and some sort of fertilizer treatment are essential for the best growth of alfalfa. Discussions regarding these features will be found on pages 9–12.

Where the land is well suited to alfalfa the seed is quite commonly sown in the early spring with a small grain sown at about one half the normal rate or occasionally in winter wheat or rye. Better stands are assured under the former practice. If the nurse crop gives evidence of injuring the alfalfa seedlings, it should be cut for hay. Early canning peas have also been successfully used as a nurse crop. Good results are often obtained where the seed is sown after an early crop of sweet corn, potatoes, or truck. Such land requires little preparation for alfalfa, provided it has been well cultivated. Small-grain crops usually mature early enough for late-summer sowings of alfalfa, but there is very likely to be a deficiency in the soil moisture at this time, due to the demands of the previous crop. An early crop of red clover may also be taken off soon enough to get the land into shape for alfalfa the same year. Such land will require considerable preparation, as it will need to be plowed and thoroughly worked before it is safe to sow alfalfa.

The quantity of seed required varies with the perfection of the seed bed, the character of the soil, and the condition of the weather at sowing time. Under favorable conditions about 12 to 15 pounds per acre has proved sufficient.

If the weather is favorable and the soil in good condition and free from weeds, it does not seem to make much difference when the seed is sown, so long as there is sufficient time for the plants to become well established before winter starts in. During midsummer, however, the weather is usually too hot and the soil too dry to insure the successful germination and growth of the seedlings. It is not advisable to sow much later than the first of September.

THE SOUTHEASTERN STATES AND THE GULF COAST

The soils in the Southeastern States and the Gulf coast region, with few exceptions, are not naturally well-suited to the production of alfalfa, and careful attention must be given to preparing the land for the crop. Consideration should be given to liming, inoculation, and fertilizing, which are discussed on pages 9–12. Weeds are especially troublesome in this section, and for this reason alfalfa should be preceded for 1 or 2 years with crops that are clean-cultivated or with such a crop as cowpeas, which chokes out the weeds. Corn and cotton are good preparatory crops. Early truck and potato crops furnish excellent opportunities for destroying weeds and may generally be taken off the land in time for sowing alfalfa. These crops leave the land in such shape that plowing is not necessary. Red or crimson clover or rye and vetch can be cut up with a disk, then turned under, and the land prepared for the late summer or early fall sowing of alfalfa. A common practice in the southern part of the region is to sow winter grain after a crop of corn or cotton has been removed. The grain is harvested in the spring and the land plowed and sowed to cowpeas as soon as possible. In the latter part of the summer the cowpeas are cut up with a disk, and the land is plowed and prepared for sowing by the latter part of September or early in October. Farther north the same system may be used, but the crop of cowpeas should be cut for hay and the land disked and harrowed for alfalfa. It is not advisable to plow under the cowpeas as far north as Virginia, as there is not time for them to decompose and the land to settle before the alfalfa is sown. In sections where considerable silage corn is produced, successful stands are sometimes obtained from sowing after the corn is removed.

In this region alfalfa is generally sown without a nurse crop at the rate of 20 to 25 pounds per acre. In the piedmont sections, in the Mississippi Delta, and on prairie limestone soils of Alabama and Mississippi good stands are secured with 20 pounds, but in the Coastal Plains, where the soils are sandy and weeds troublesome, less than 25 pounds per acre is not advisable.

In the northern part of the region under consideration sowings made about the middle of August on an average have given the best results. In the South Atlantic and Gulf States the date of sowing may be delayed with safety until the middle of October, and when weather conditions are especially favorable successful stands are sometimes obtained from sowings made as late as the 1st of November, although they are not recommended. Early spring sowings—that is, in March—are sometimes successful in the extreme South.

SEMIARID CONDITIONS

Alfalfa is grown quite extensively in parts of the West where the rainfall is limited, and where water is not available for irrigation. In this region the soil-moisture conditions are usually most favorable in the spring, and in the North it has generally been considered the best practice to sow as early in the spring as the ground can be put in shape; but recent experiments indicate that, in some sections at least, weeds are less troublesome where sowing is delayed until the 1st to the 15th of May. This gives opportunity to work up the seed bed 2 or 3 times, thus destroying many of the weeds. If sowing is delayed until the weather is hot and dry, there is danger that the plants will not become well enough established to survive the winter. South of Kansas the seed may be sown either in the spring or early fall. Moisture conditions usually are most favorable in the spring, but weeds are likely to prove more troublesome when the seed is sown at this time. For this reason many growers prefer to keep the land cleanly cultivated during the summer and sow the seed in the late summer or early fall.

Preparation for alfalfa should begin somewhat in advance, to insure sufficient moisture for the young seedlings. Where the seed is to be sown in the spring the land should be summer-fallowed the previous year or else devoted to some cultivated crop, such as corn, to assist in freeing it of weeds and to conserve the moisture. Except on heavy soils it will not be necessary to plow again, but where it seems advisable it should be done in the fall and the land disked and harrowed as soon as it is in condition to work the following spring. Land to be sown in the late summer or early fall should be plowed the previous fall and kept cultivated throughout the spring and early summer.

The use of a nurse crop is not recommended under dry-land conditions, as it draws too heavily on the rather limited moisture supply. However, good stands are frequently obtained with one third or one half the normal rate of sowing of some small-grain crop, particularly where it is cut early for hay. Good results are also secured from the use of flax as a nurse crop.

Over most of the dry-farming area less seed is required than is advised under humid conditions or under irrigation, partly owing to the fact that weeds are less troublesome. Ordinarily, from 8 to 10 pounds of seed per acre will be ample. Good stands have been obtained with 2 to 4 pounds, but such light rates cannot be recommended for general practice.

SANDY SOILS

In the Eastern States alfalfa usually does not survive long on very sandy soils, although fairly good yields may be obtained for 2 or 3 years where liberal applications of stable manure are made prior to sowing the seed. West of the Mississippi River such soils, if not too sandy, usually will grow alfalfa successfully after the plants are once well established. However, it is often difficult to start the crop on soils that are so light in texture that they drift badly, as the young plants are likely to be cut off by the sand unless special precautions are taken. This may be avoided by applying a light top-dressing of straw or coarse manure just after sowing. Another method that has proved quite satisfactory is to scatter a thin layer of wild hay or straw from an old stack bottom over the land immediately after the seed has been sown. The field is then gone over with a weighted disk set straight. This cuts the hay into the ground and leaves it standing over the field, much like stubble. Good results are also had where the alfalfa is drilled into high-cut stubble of sorghum or millet. Where cornland is used and the field is in good shape, it may be prepared by disking down the stalks early in the spring and leaving the soil rough until time for sowing. The alfalfa seed may also be sown with about a peck per acre of rye, barley, or some other small-grain crop which will make a rapid growth and protect the young alfalfa seedlings. Unless there is danger of injury from drifting soil the nurse crop should be avoided, as it is likely to draw so heavily on the soil moisture as to injure the alfalfa.

The rate of sowing generally advised is from 10 to 15 pounds per acre. The press drill gives the best results, but where this is not available the seed may be sown broadcast, the land harrowed, and then rolled to get the seed into contact with the moist soil and hasten germination. After rolling, it is best to harrow the soil lightly so as to reduce the possibility of the formation of a crust on the surface.

SOWING ALFALFA UNDER IRRIGATION

In preparing land for alfalfa the first step is to break it deeply and then level it if necessary. Plowing should be done several weeks in advance of sowing, so that the soil may be properly compacted by the use of a heavily loaded disk, a roller, or some other suitable implement. Ordinarily it is best to irrigate the land just prior to sowing the seed; and, as soon as it has dried out sufficiently, the surface should be worked up into a fine mellow seed bed. If possible, further irrigation should be avoided until the plants have developed three or four leaves. Good stands are sometimes obtained where the seed is "irrigated up", but the practice is not recommended, particularly on heavy soils, as the surface often becomes so crusted that the young plants are unable to break through.

For ordinary conditions the rate of sowing should be about 15 pounds per acre, although a smaller quantity may give good stands under ideal conditions. Generally speaking, somewhat less seed seems to be required in the northern irrigated districts than farther south, probably because weeds are somewhat less troublesome. The time of sowing will depend upon frost conditions, but should be early enough to allow the plants to become well-established before cold weather. In the extreme Northern States the best stands are obtained where the seed is sown as early in the spring as it is possible to get the land in condition. Ordinarily, at this time of the year the soil contains considerable moisture as a result of the winter precipitation, and irrigation prior to sowing is not essential. Another advantage of early spring sowing is that during the cool weather the soil does not dry out very rapidly, so that the plants have an opportunity to become well-established before irrigation is necessary. In Montana and the Dakotas the latter part of April or early in May is about the earliest date that alfalfa can be sown safely. Under favorable conditions in these States good stands have been obtained where seed was sown on disked grain stubble in the late summer. In the extreme Southwest good stands may be secured from sowing almost any time between October 1 and April 15, although the December and January sowings are occasionally injured by cold weather. October is the most favorable month, but where it is impossible to get the land in shape in the fall, February and March sowings usually give quite satisfactory results. The hot summer months constitute the most trying period.

As a rule, the best stands are secured where the alfalfa is sown alone. In the Northern States, however, a nurse crop is not particularly objectionable, provided it is sown at about one half or one third the usual rate. In the Southwest it is best to avoid the use of a nurse crop.

TREATMENT OF STANDS

Late summer or fall sown alfalfa requires no treatment that season. Even though the plants make considerable growth before being checked by frost, they should not be cut. Where alfalfa is sown in the spring, weeds usually appear in abundance, and the important question is whether it is better for the alfalfa if the weeds are cut back or allowed to grow. There is a generally prevailing theory that the frequent cutting of young plants forces them to stool out and increases root growth, but carefully controlled experiments have demonstrated quite clearly that such treatment actually checks root development. Even where the weeds are very rank, such evidence as is available indicates that it is better to delay clipping until the young alfalfa plants have reached the proper stage, that is, until they are in bloom. While the earlier clipping may check the weed growth to some extent, it also weakens the alfalfa seedlings and lessens their ability to compete with the weeds.

When the field is cut, the growth should be removed if there is any danger of smothering the seedlings; otherwise it may be left on the ground as a mulch. In the northern Great Plains and intermountain region the weeds in alfalfa have been allowed to go unclipped throughout the first season, the subsequent stand of alfalfa benefiting by such treatment. Where this is done it is advisable to get rid of the dead growth early in the spring. In the North. where only hardy alfalfas are grown, this has been accomplished by burning over the fields, but the more tender alfalfas are sometimes injured by such treatment. Where it is not safe or convenient to burn off the fields the dead growth may be raked up and hauled off. In the South and Southwest it is often possible to procure two or three cuttings of hay the first year from spring sowings, and where this is the case the recommendations made above do not apply.

Alfalfa should not be pastured at all the first year, and only lightly the second year. It should never be pastured closely, as the grazing-down of the crowns often results in killing the plants. Cattle should never be allowed access to a field when the ground is wet or frozen. Owing to the difficulty of securing a good stand in the East, it is very doubtful whether alfalfa in that section should be pastured at all.

If the stand becomes thin or patchy the field should be plowed up and reseeded after it has been planted to some other crop for a year or more. Attempts to patch up poor stands generally prove futile.

In the East a top dressing of well-rotted stable manure applied in the late fall or winter not only furnishes some protection but in most cases also increases the yield the following season. If stable manure is not available, an application of 300 to 500 pounds of superphosphate per acre in the spring is of considerable assistance in maintaining the vigor of the stand.

CULTIVATING ALFALFA

For many years writers have advocated the disking or harrowing of alfalfa fields, on the theory that it increases the yield and prolongs the life of the stand. While some form of cultivation appears advisable under certain special conditions, any general statement to the effect that alfalfa fields are always benefited by such treatment is certainly open to question. Where irrigation waters leave thick deposits of silt on the field the use of the harrow to break up such deposits appears advisable; also where irrigated alfalfa is pastured, some sort of cultivation to loosen the soil that has been compacted by trampling, particularly the heavy-textured soils, may be beneficial. Where weeds and grass threaten to crowd out the alfalfa the life of the stand may often be profitably prolonged for a year or two by harrowing. Generally speaking, however, there is little or no advantage to be gained by cultivating broadcast alfalfa so long as the stand is satisfactory and the plants are making good growth. Extensive experiments have shown that under such conditions the increase in yield, if any, is not sufficient to pay the additional cost of producing the crop, and the life of the stand is prolonged but slightly, if at all.

The best implement for cultivating alfalfa is the so-called alfalfa harrow, which is a modified form of the spring-tooth harrow (fig. 5). This implement loosens the soil without seriously injuring the plants. The spike-tooth harrow will loosen up the lighter textured soils. but is of little benefit on the heavy soils. Experience has shown that in most cases the use of the disk harrow is actually injurious, as any implement that has a tendency to split the crowns renders the plant more susceptible to certain diseases.

The best time for cultivating a field of alfalfa will depend upon the object to be gained. Ordinarily it should be early in the spring or immediately after any one of the cuttings. Alfalfa should never be cultivated the first year after sowing, as the plants are so small that they are easily pulled out and killed.

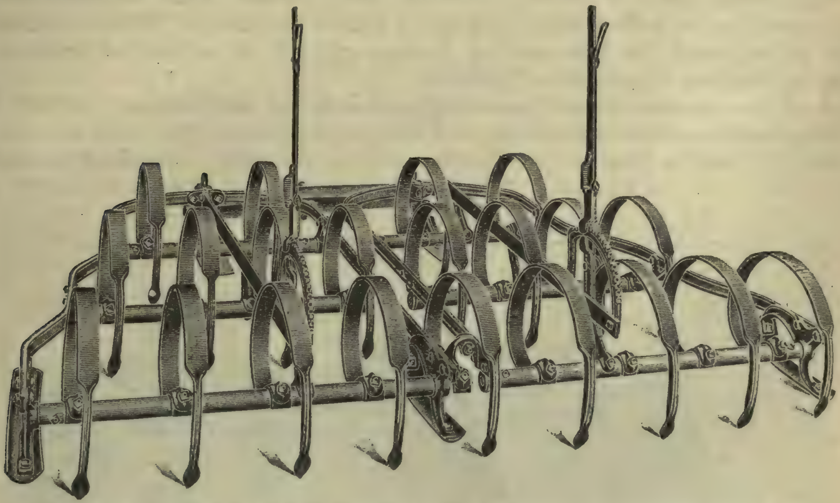

FIGURE 5.—Type of harrow commonly used in cultivating broadcast alfalfa.

MAKING ALFALFA HAY

Most of the alfalfa grown in this country is cut for hay. The number of cuttings obtained depends upon climatic conditions, the soil, and the variety, and varies from 8 or sometimes more in the far Southwest to 2 and sometimes only 1 in the North and semiarid sections. From 30 to 40 days are required to produce a hay crop.

The stage of growth at which alfalfa is cut has a marked effect on the feeding value of the hay, the life of the stand, and yield. Hay of the highest feeding value results from early cutting owing to the greater proportion of leaves, which contain twice as much protein as the stems. Continued cutting as early as the bud stage, however, has been shown repeatedly to shorten the life of a stand very materially under most conditions. Stands survive longer and yields often are larger where harvesting is delayed until the plants are in full bloom, but this is at the expense of the feeding value of the hay.

Recent experiments indicate that under certain conditions, at least, the first or the first and second growth may be removed at the bud or early-bloom stage without shortening the life of the stand provided one or more of the later cuttings are delayed until full bloom. By following this practice a better quality of hay is obtained from the early cuttings, which are generally rank and coarse. Whether one or more cuttings are removed at the early stage will of course vary with the number of crops obtained during the year. In the East alfalfa blooms very sparingly when the season is too wet or too dry; therefore it is very difficult to determine the stage of maturity by the flowering. When this is the case the growth of the basal shoots and general appearance of the field should serve as a guide for cutting. If the basal shoots have made considerable growth and if the foliage is beginning to take on a yellow cast, indicative of the slowing up or stopping of growth, the field should be harvested regardless of the percentage of bloom. Under most conditions alfalfa should go into the winter with considerable growth; otherwise winter-killing is likely to occur. When alfalfa is killed back by late spring freezes cutting is advisable without consideration for stage of growth.

As the leaves contain about two thirds of the feeding value of the plant, an effort should be made to get the hay in the stack or mow with as large a proportion of the leaves as possible. The hay should be left in the swath until it is well wilted but not brittle, the length of time depending upon the weather and the growth. It should then be raked into a windrow with a side-delivery rake and turned occasionally with the same type of rake to hasten curing. Where the acreage is small, alfalfa is often cured in cocks, occasionally being covered with hay caps consisting of a piece of canvas about 3 feet square, which of course increases the labor and expense very materially and is not practical for large acreages. Where the weather is uncertain, partial curing in the swath and finishing in the windrow is to be preferred, as the hay can often be put into the barn, while that in cocks may be spoiled owing to the longer time required for curing.

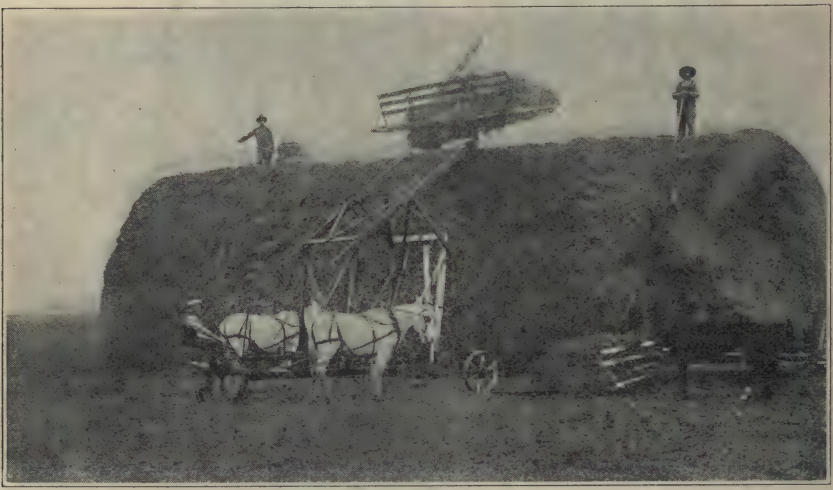

FIGURE 6.—Stacking alfalfa.

The least loss is sustained where the hay is placed in the barn, but in the big alfalfa districts such space is not available, and most of the alfalfa is stacked (fig. 6). Many of the stacks are carelessly built and left unprotected in spite of the fact that the saving effected nearly always justifies some sort of covering and the effort involved in building a well-shaped stack. Canvas, boards, corrugated sheet iron, or coarse grass may be used to cover a stack of alfalfa. The stacks should be as large as practicable, and in order to shed water properly they should be somewhat larger at a height of 6 feet than at the base. Alfalfa should not be put in the barn too green, as it is likely to heat and in extreme cases has been known to become so hot as to cause a fire. Where hay is stacked before it is properly cured, fermentation takes place, resulting in a brown hay. Experiments indicate that good brown hay is somewhat superior to green hay in palatability but that it is not superior to green hay in feeding value.

USES OF ALFALFA

Well-cured alfalfa is more readily eaten by all classes of farm animals than any other kind of hay. Chemical analyses show little difference in alfalfa hay and that made from certain other legumes, such as cowpeas, soybeans, and clover, but it is generally somewhat more palatable. As a pasture plant alfalfa is relished highly, and fields of it have a large carrying capacity; but if it is utilized in this way considerable caution should be taken, as a good stand is easily injured by overgrazing (fig. 7). Alfalfa should never be pastured the first year and should be pastured only lightly the second year. Ordinarily hogs are less injurious to alfalfa than other classes of livestock. Care should be taken in pasturing sheep and cattle on alfalfa, as they are subject to bloat; horses, mules, and hogs are not.

FIGURE 7.—Dairy cows grazing on alfalfa.

Good silage may be made from alfalfa, provided the material is finely cut and thoroughly packed, but as ordinarily put into the silo it does not keep as satisfactorily nor as long as silage made from corn. Its chief disadvantages are the labor involved in putting it up and the lack of sufficient tonnage. Where it is possible to make good hay it seldom pays to make silage of alfalfa. Alfalfa makes an excellent soiling crop so far as yield is concerned, but it should be cut no oftener and no earlier in the stage of development than when it is cut for hay. In parts of the West large quantities of alfalfa are ground into meal. Much of this meal finds its way to the eastern markets either unmixed or mixed with molasses and various feeds. The mere grinding of the hay into meal does not increase its feeding value, but it is fed with less waste and is in convenient form for city and town use. It also gets the benefit of a considerably lower freight rate than hay. Attempts have been made to extend the use of alfalfa to the making of human food, medicines, textiles, dyes, and other commercial products, but the plant has little or nothing to commend it for such uses.

SEED PRODUCTION

Alfalfa produces seed in paying quantities only where the summer rainfall is comparatively light. For this reason the commercial production of alfalfa seed in the United States is confined largely to that portion lying west of the ninety-fifth meridian. Most of the seed of the Grimm variety is produced in Idaho, Montana, North Dakota, and South Dakota. The Peruvian alfalfa seed industry is confined almost entirely to the Yuma Valley of California and Arizona. In abnormally dry seasons considerable seed has been produced east of the ninety-fifth meridian. Ordinarily it is more profitable for the farmer in the Eastern States to purchase seed that is produced in the West than to attempt to grow it himself.

For its best development the alfalfa-seed crop requires a hot, dry season, and as a result it is customary to save that crop for seed which matures during the hottest and driest part of the summer. Over much of the country this is the second crop, but south of Kansas it may be the third crop. In the extreme North the season is usually so short that it is necessary to leave the first growth for seed. For a short time in the spring some growers pasture fields that are to be devoted to seed production.

For a seed crop alfalfa should be cut when two thirds to three fourths of the pods have turned brown. The crop may be harvested with a mower having a bunching attachment or with a binder having the tying attachment removed. This leaves the alfalfa in convenient forkfuls and reduces shattering in handling. Where possible, alfalfa is threshed from the field, but in some cases it is necessary to stack it. An alfalfa huller is the most satisfactory thresher, although the ordinary grain thresher equipped with alfalfa sieves and with the concaves screwed down does quite satisfactory work. The average yield of seed per acre runs from 2 to 4 bushels. The total production of alfalfa seed in the United States during the last 5 years has ranged from approximately 32,000,000 pounds in 1932 to 70,000,000 in 1930. The amount of seed imported during this period was much less than that imported during the preceding period; the greater part of the seed came from Canada.

BREAKING ALFALFA SOD

Farmers often complain of the difficulty of breaking up and destroying a stand of alfalfa, but under most conditions this need not offer any serious objection to the crop provided the necessary equipment is at hand; that is, strong horses and a sharp plow.

The plow should be in good condition when it enters the field, and the operator should carry a file to keep it sharp. It is of course more difficult to keep the plow in condition in gravelly or stony soil.

The furrow slice should be 2 inches less in width than the plow will turn. This is to prevent any of the large roots from slipping by uncut. Sometimes the plows are provided with a knife attachment to the landside to cut the roots near the outer edge of the next furrow. The most successful practice is to plow shallow in the fall and deep the following spring. Where only one plowing is practicable this should be rather shallow. If plowed too deeply the roots frequently retain enough life to start again. Ordinarily it is better to leave the furrow slice to dry out some time before cultivating, as this assists in killing the roots.

WEEDS

In most of the United States weeds constitute the worst enemy of alfalfa. Dodder, a threadlike yellow twining plant which lives as a parasite on plants, is very objectionable in seed-producing districts, as there is little or no market for alfalfa seed that carries seeds of dodder with it, and the two seeds are very difficult to separate. Dodder seldom gives much trouble in fields that are devoted entirely to the production of hay. Other troublesome weeds are Kentucky bluegrass and quackgrass in the northeastern one fourth of the United States; crabgrass and Bermuda grass in the Central and Southern States; and foxtail or wild millet in the Middle West and the Great Plains. In the irrigated sections of the West the wild barleys, also known as foxtail and squirreltail grass (*Hordeum* spp.), are decidedly troublesome, as the beards ruin the first crop of hay for feeding unless it is cut very early. Where weeds are troublesome in the West, wheat is sometimes drilled in the alfalfa in the fall, and as it comes on early the growth of the weeds is checked. The first cutting of hay the following spring consists of a mixture of alfalfa and wheat. Cultivation of established stands of alfalfa may help to hold the weeds in check, but unless done with considerable care the alfalfa may be injured. The most satisfactory way to control them is to make the conditions so favorable for alfalfa that the weeds are smothered out. When they become abundant it is better to plow the field rather than attempt to get rid of them by cultivation.

DISEASES

The most destructive alfalfa diseases in the United States include bacterial wilt *Phytomonas insidiosa* (McC.) Bergey et al.); root rot (*Phymatotrichum omnivorum* (Shear) Duggar); crown wart (*Urophlyctis alfalfae* (Lagh.) Magn.); leaf spot (*Pseudopeziza medicaginis* (Lib.) Sacc.); yellow leaf blotch (*Pyrenopeziza medicaginis* Fckl.); and "alfalfa dwarf."

Bacterial wilt is regarded as the most serious disease attacking alfalfa at the present time. It is quite generally distributed but is especially destructive in some of the best alfalfa districts of the Middle West and West. It is much less prevalent in the extreme

East. Where the disease is serious, stands of alfalfa seldom survive more than 2 or 3 years. The only known means of controlling the disease is to use resistant alfalfas such as Turkistan, Hardistan, Ladak, and Kaw.

Root rot results from a fungous parasite upon the roots of alfalfa, causing the plants to die out in well-defined, usually circular areas, which gradually increase in size. It occurs from eastern Texas to southern California and is the disease which attacks cotton and other taprooted plants. Land on which the root rot occurs should be planted to some fibrous-rooted crops, such as corn, sorghum, or some small grains, for several years until the fungus disappears.

Crown wart has been observed on the prairie limestone soils of Mississippi and in many of the States west of the Mississippi River, but it occurs in the greatest abundance in California. The disease is characterized by the appearance of galls on the crown at the base of the stems. These galls, which are caused by a fungus, are much warted externally and vary in size from one eighth to 3 or 4 inches in diameter. Affected plants are seldom killed outright; but the growth is checked and the plants weakened, and smaller yields result. Where the disease becomes serious the land should be plowed and put into some other crop until the gall fungus is eliminated.

Leaf spot is a fungous disease, which is very common where alfalfa is grown and may develop in all conditions of soil and weather. It is more destructive in humid than in dry sections. The disease is characterized by small brown spots about the size of a pinhead which are present on both sides of the leaves. Badly affected leaves turn yellow and drop off, thus reducing the yield and feeding value of the hay. Where the field becomes very badly infected with the disease it is recommended that the crop be cut and removed.

Yellow leaf blotch is also a fungous disease which is common in all large alfalfa-growing regions of the United States. The disease attacks the leaves and is characterized by long yellow blotches which are sprinkled with minute brown dots. Where it is serious it is best to cut the crop.

"Alfalfa dwarf" is the name applied to a disease resembling bacterial wilt, the cause of which has not as yet been determined. This disease is quite serious in parts of southern California, particularly south of the Tehachapi Mountains, and may destroy a stand in 2 or 3 years.

Rust is quite prevalent on alfalfa during some seasons and where abundant tends to check the growth and to cause shedding of the leaves. When such a condition develops the alfalfa should be cut.

INSECTS[1]

It is probable that grasshoppers do more damage to alfalfa than any other insect. They occur in all parts of the country but are most often destructive in the arid and semiarid districts. The most effective means of control is the use of poisoned-bran mixtures. The formula generally recommended is made up as follows: Coarse wheat bran, 100 pounds; crude arsenic, 5 pounds; cane molasses, 1½ gallons; water, 10 to 12 gallons. The bran is spread out on a tight floor or in a wagon box or similar container to a depth of 8 to 10 inches. The required quantities of water, arsenic, and molasses are mixed thoroughly in a large can or barrel. This mixture is then splashed over the bran, about 3 gallons at a time, and the bran is worked into a mash by turning it over with a scoop shovel, potato fork, or garden rake. The liquid must be stirred constantly, as otherwise the poison soon settles out. About 200 pounds of bran is all that can easily be mixed in a wagon box at one time, but on a floor where there is plenty of room about 500 pounds can be handled. Good results depend on mixing the mash thoroughly until it contains no lumps and is moist throughout. It should fall in flakes when scattered with the hand. More detailed directions for the control of grasshoppers can be found in Farmers' Bulletin 1691, How to Control Grasshoppers in Cereal and Forage Crops.

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[1] Contributed by the Bureau of Entomology, U.S. Department of Agriculture.

The alfalfa weevil is quite destructive in parts of the West. It made its first appearance in Utah in 1904, and has spread to Idaho, Nevada, Wyoming, and western Colorado, eastern and southern Oregon, the San Francisco Bay district, and the northeastern corner of California. The insects feed on the green leaves and where numerous cause considerable damage. The most effective means of control is to time the cuttings of the crop so that the immature stages of the weevil are killed by exposure to heat immediately following the removal of the crop. Control can also be accomplished by means of a thorough application of calcium arsenate, the powder form being mixed with water to make a spray. The approved formula is 2 pounds of calcium arsenate to 100 gallons of water, this quantity to be applied as a spray to 1 acre of alfalfa. Where this application is made at a time when the growing tips of the plants are beginning to show serious injury from the weevil, it results in complete control of the insect for the current season, subsequent cuttings of the crop usually being practically free from the pest. Further details on the control of the alfalfa weevil can be found in Farmers' Bulletin 1528, The Control of the Alfalfa Weevil.

One of the most serious of all alfalfa troubles is the yellowing of the plants resulting from leaf-hopper attacks. While this seldom kills the plants outright its attacks are doubtless responsible for material reduction in yields of alfalfa, particularly in the Eastern States. Yellow fields should be cut regardless of the stage of development.

There are a number of other insects that do more or less serious damage to alfalfa. Among the more important of these are the alfalfa seed chalcis fly, garden webworms, the clover root borer, the clover root curculio, the clover stem borer, alfalfa aphid, the alfalfa caterpillar, clover leaf weevils, various cutworms and army worms, blister beetles, crane flies, the red harvester ant, thrips, the tarnished plant bug, and the alfalfa looper. Information on the control of these pests can be obtained by applying to the Bureau of Entomology, United States Department of Agriculture.

RODENTS

The most troublesome animal pests encountered in growing a crop of alfalfa are gophers, ground squirrels, prairie dogs, and mice. They are especially troublesome in the western half of the country, where they eat the roots of the plants. Where irrigation waters are available these pests are controlled to some extent by drowning. Poisoning and trapping are the best means of holding them in check, but because of the danger attending the careless use of poisons it is suggested that the farmer get in touch with the county agricultural agent or a representative of the Bureau of Biological Survey of the United States Department of Agriculture whenever these pests become troublesome.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1723

Revised Feb 40

FEEDING, CARE, AND MANAGEMENT *of young* DAIRY STOCK

1862 1889

THE sure road to the development of a high-producing dairy herd is the raising of strong, healthy calves that have an inheritance for high milk and butterfat production.

Breed the cows in the herd to a registered dairy bull whose breeding is such as to insure the maximum probability of his transmitting to his progeny the hereditary factors that will determine a high level of production.

Give the pregnant cow and new-born calf the proper feeding and care.

Give the growing calf suitable feed and care so that it will develop properly.

Cleanliness is essential in all the details of feeding and care.

Feed whole milk for the first 2 to 4 weeks of the calf's life. After this age the calf can be gradually changed to fresh skim milk; or to any one of a number of milk products, or to a special calf meal. Calves make good use of milk or milk products up to 6 months or more of age.

Besides milk, the calf also needs a good quality of hay cured so as to retain its natural green color and most of its leaves, and a suitable grain mixture, to insure getting all the required nutrients, including minerals and vitamins.

Heifers over 6 months of age require an abundance of pasture in summer, and hay or hay and silage in winter, with sufficient grain in addition, to supply the nutrients for normal growth.

Dry, clean, well-bedded, and well-ventilated but not drafty quarters are required for dairy calves. Older heifers can be housed in a shed open to the south.

All ailments and diseases require prompt and proper treatment. Cleanliness is one of the best disease preventatives.

These and other points essential to raising good dairy stock are discussed in the following pages.

This bulletin supersedes Farmers' Bulletin 1336, Feeding, Care, and Management of Dairy Calves and Young Dairy Stock; Leaflet 20, Care of the Dairy Calf; and Leaflet 14, Raising the Dairy Heifer.

Washington, D.C. Issued April 1934

FEEDING, CARE, AND MANAGEMENT OF YOUNG DAIRY STOCK

By J. B. SHEPHERD, *associate dairy husbandman*, and FRED W. MILLER, *senior veterinarian and physiologist, Division of Dairy Cattle Breeding, Feeding, and Management Investigations, Bureau of Dairy Industry*

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RAISING CALVES FOR HERD REPLACEMENTS

THE maintenance of a herd of high-producing dairy cows calls for the raising, for replacement purposes, of healthy, well-grown calves that have an inheritance for a high level of milk and butterfat production. To breed such calves healthy, high-producing cows should be mated with a carefully selected, registered dairy bull of good conformation, whose breeding is such as to insure the maximum probability for his transmitting the hereditary factors for high production to his offspring.

The feeding for proper growth and development of the dairy calf begins before it is born. The pregnant cow should be given sufficient feed so that she will be in fair to good flesh at calving time, and the ration fed should be adequate in vitamins and minerals. Cows fed rations greatly deficient in these important substances may give birth to weak, puny calves that are hard to raise. A strong, vigorous calf is more likely than a weak calf to respond normally to proper feeding and care, and to develop into a large-sized animal capable of producing up to its inherited capacity.

CARE OF THE FRESHENING COW

Cows freshen normally from about 270 to 290 days after breeding. The majority freshen within 275 to 285 days, with an average of about 280 days. Where accurate breeding records have been kept, the date of freshening can be calculated to within 1 to 10 days. This makes it possible to dry the cow off at the right time and give her the proper feeding and care during the dry period and at calving time.

Several days before the calf is due to arrive, separate the cow from the rest of the herd and place her in the calving quarters. During cold weather this should be a roomy, well-bedded box stall that has been thoroughly cleaned and disinfected. Keep the box stall clean and well-bedded, so that when the calf arrives it will be dropped in a clean, dry place. A small, well-grassed plot or pasture free from trash or manure and close to the barn makes a good calving place in summer.

The first indications of approaching calving are a pronounced swelling and enlarging of the vulva and a dropping away or sunken condition on either side of the tail setting. When these signs are noted, the cow should not be disturbed, but her condition should be observed from time to time. If everything is progressing normally, she will usually give birth to her calf without any assistance. Proper assistance should be given to the cow or to the calf if it is required. Such assistance may prevent the loss of a calf.

Detailed information regarding the feeding and management of the dry cow and care of the cow at calving time is contained in Farmers' Bulletin 1470, Care and Management of Dairy Cows.

CARE OF THE NEW-BORN CALF

Immediately after it arrives, the calf should be given attention. Remove any membrane or mucus from its mouth and nostrils. If the calf lies motionless and does not start breathing promptly, try to help start respiration by slapping the chest vigorously or by the alternate compression and relaxation of the chest.

The cow in normal condition is much concerned with the welfare of her calf, and usually begins to dry the calf at once by licking it vigorously. If she does not, or if the air is cold and damp, rub the calf dry with burlap or some other suitable material.

The new-born calf is very susceptible to disease germs. These may gain entrance through the navel or the digestive tract. To guard against navel infection, apply tincture of iodine to the navel at birth and dust with boric acid powder. If a long cord is attached to the navel, clip it off about 2 inches from the body before applying the iodine.

Be careful to keep the box stall clean and well-bedded while the calf remains with the cow, in order to lessen the danger of infection by contamination with filth.

A normal calf is able to stand shortly after birth, and within half an hour it may be nursing. If the cow's udder is soiled, there is danger of the calf being infected from this source. Wash the udder with warm water and soap, and rub dry at once with a clean cloth. Sometimes the calf is so weak that it must be held up to the cow's udder to help it get started to nurse. If it does not suck at first, milk a small stream of milk into its mouth. If the weak calf cannot be induced to suck by this method, try feeding it warm milk from its mother in a bottle, either with or without a nipple.

Be certain that the calf gets one or more good feeds of the first milk or colostrum. This milk is different in composition from normal milk (p. 10). It helps to clear out the digestive system and protects the new-born calf against infection from harmful bacteria gaining entrance through the digestive system. Experiments to determine the effect of withholding colostrum milk from calves show that where it is not fed, many calves die from the effects of infection from harmful bacteria.

If the cow and the calf are both progressing normally, the calf should not be left with the cow longer than 12 hours. When this period has elapsed it is best to remove the calf, because a calf which has been left too long with its dam is harder to teach to drink than one removed soon after birth. Also, the longer a calf is left with its dam the more the cow and calf will worry when they are separated.

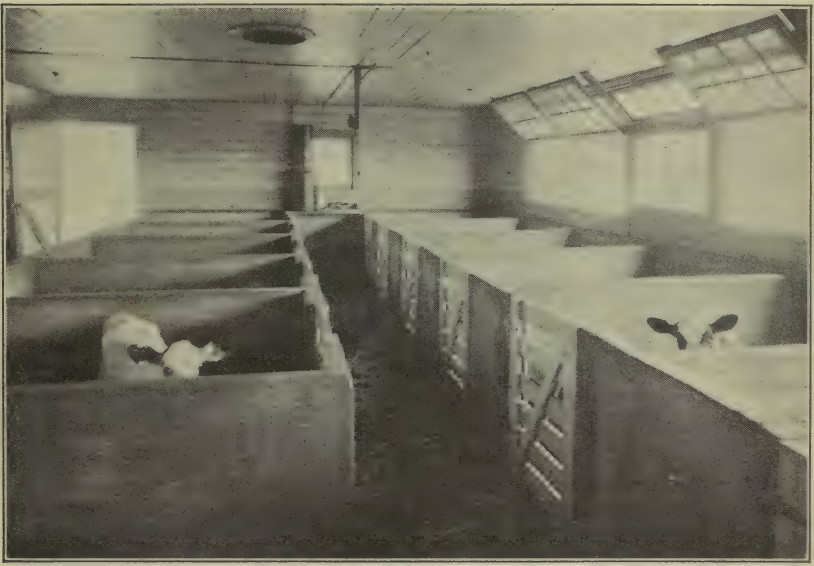


FIGURE 1.—Individual pens for young calves, Beltsville (Md.) Experiment Station.

QUARTERS FOR THE YOUNG CALF

When the calf is taken from its dam, place it in a small individual pen by itself where it cannot be jostled around or the navel injured by being sucked by other calves. A separate pen will also make it easier to feed and care for the calf and note its condition of health.

The pen should be light and well-ventilated but free from drafts and not too cold. It should be thoroughly cleaned and disinfected before the calf is placed in it, and kept well-bedded with dry material. Cold drafts and cold, damp pens are frequent causes of diarrhea, colds, and pneumonia.

To disinfect the calf pen, scrape off any manure remaining on the floor or walls, and scrub them thoroughly with hot water or an alkaline washing powder. When the floor and walls are clean, apply a suitable disinfectant to them with a spray pump, forcing the disinfectant into all small cracks and openings. Disinfectants and the disinfection of stables are discussed in detail in Farmers' Bulletin 954, The Disinfection of Stables.

In order to keep the calf from licking other calves or objects outside the pen, the sides should have no open spaces and be at least 3½ feet high. This helps to protect the calf from disease germs and may also aid in preventing the spread of disease to other young calves. Figure 1 shows individual pens for young calves. A temporary individual pen is shown in figure 2.

The pen should be equipped with a small box for grain and a small slatted rack for hay, as the calf will be learning to eat these feeds before it is placed with other calves.

By the time the calf is 3 or 4 weeks old, its navel has healed, and it has gained in strength and vigor. It can then be placed in a larger pen with other calves of about the same age. This pen should be equipped with stanchions (figs. 3 and 4), which permit each calf to feed individually without interference from other calves, and a slatted rack conveniently placed so that the calves can eat hay at any time when not confined in their stanchions. At this age the calves should also have access to a well-drained lot or small pasture, where they can be turned out to get plenty of exercise and direct sunlight when it is not too cold or stormy.

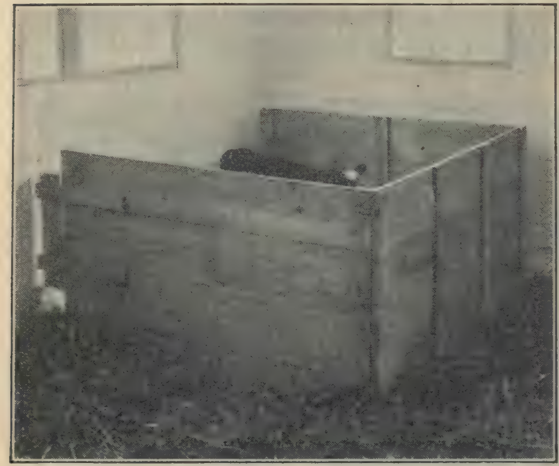


FIGURE 2.—Temporary pen, made from three solid wood panels, for the young calf.

The floor plan of a well-arranged maternity and calf barn is shown in figure 5.

CLEANLINESS IN FEEDING AND CARE

Calf diseases and many disturbances of the stomach and digestive system are caused by harmful bacteria which multiply in filth and dirt. Thorough cleanliness is absolutely essential in the successful raising of calves. This is equally true of the feed, pens, bedding, and the pails and other utensils.

All milk fed should be fresh and clean. All other feeds should also be fresh and wholesome. Keep the calf pens clean and well-bedded with dry material. Remove all discarded feed from the feed boxes every day. After each feeding thoroughly wash and scald or steam the pails, cans, and other utensils used in feeding milk or gruel to calves. If steaming equipment is not available, place the utensils on a drying rack in direct sunlight after they have been washed and scalded. This will help to keep them sweet and clean.

Milk from cows infected with a communicable disease such as tuberculosis and Bang's disease (infectious abortion), and skim milk, buttermilk, or whey from a creamery or cheese factory, should always be pasteurized before being fed, because it is impossible to know whether such products are free from bacteria that cause disease.

Creameries and cheese factories usually pasteurize such products before making them available for feeding purposes. If they have not been pasteurized, the necessary pasteurization can be accomplished on the farm by heating them to 150° F. and holding them at this temperature for 30 minutes, or by heating them to 180° F. and cooling immediately.

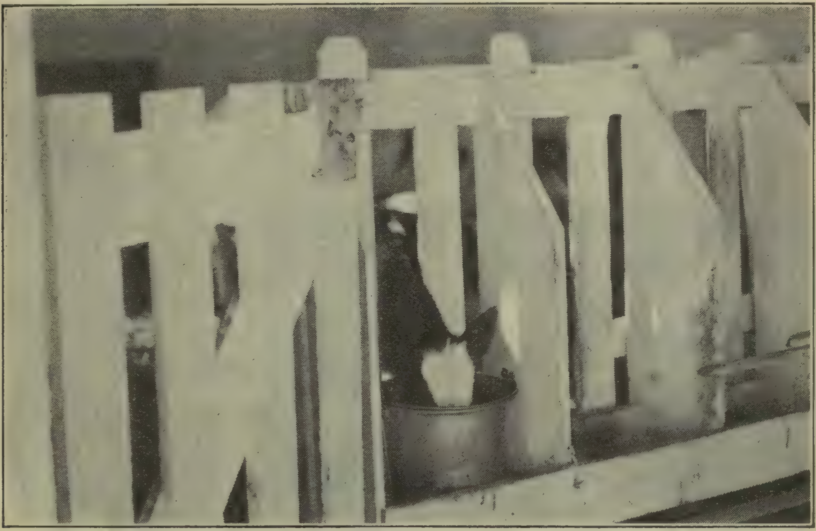


FIGURE 3.—Home-made calf stanchions and mangers.

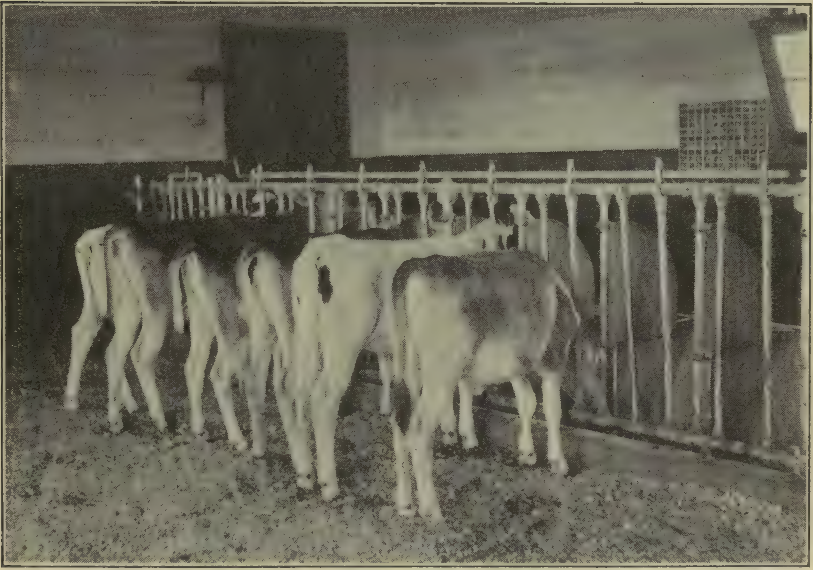


FIGURE 4.—Steel calf stanchions and mangers.

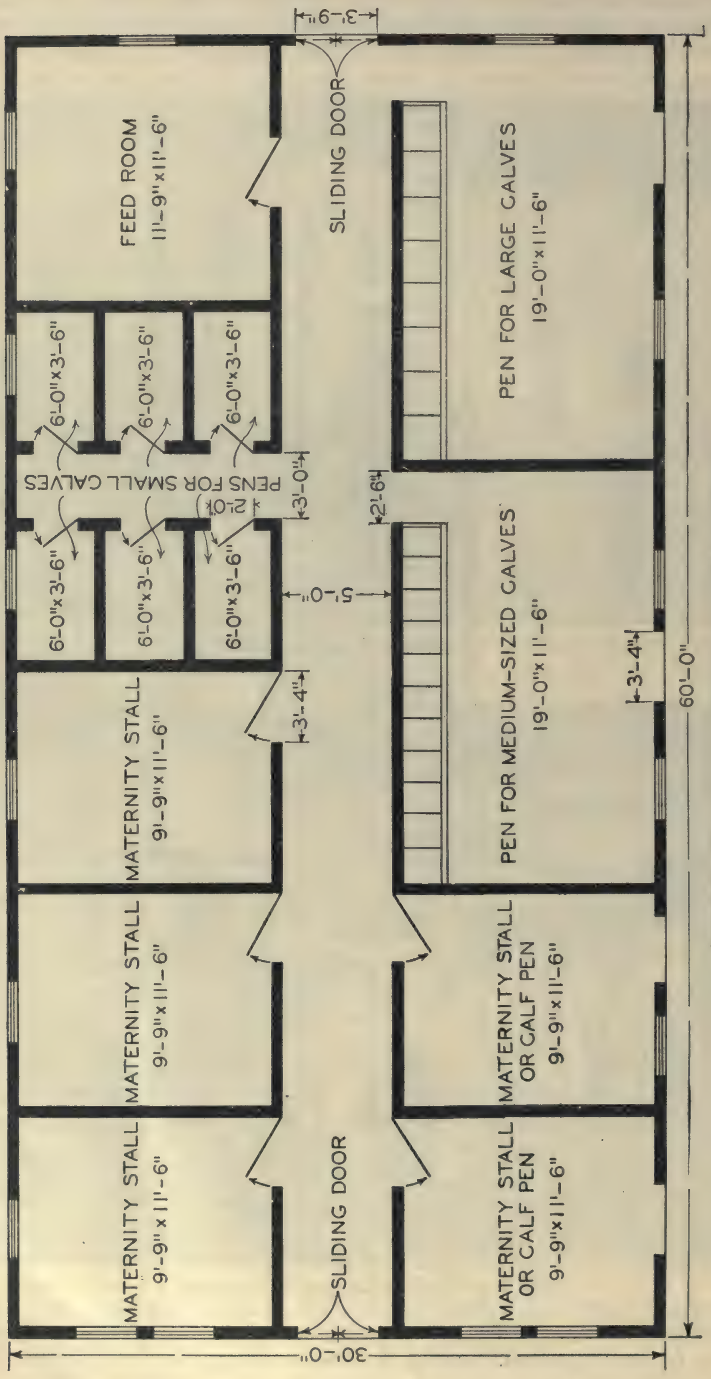


FIGURE 5.—Floor plan of a convenient maternity and calf barn.

TEACHING THE CALF TO DRINK

After the calf has been taken from its dam, do not feed it for at least 12 hours. It will then be hungry and can usually be taught to drink quite readily. A calf being taught to drink should always be handled gently.

For the first feeding place a quart of fresh warm milk from the dam in a clean pail. Hold the pail of milk on the floor in front of the calf, taking care to keep as far away from the calf as possible. The normal calf will nose around the pail, and will often begin to suck up or drink the milk of its own accord. If it does not, dip two fingers in the milk and place them in the calf's mouth. If the calf will not suck the fingers, raise its head, open its mouth, and pour in a teaspoonful of milk, taking care that the calf does not get any milk into its lungs, and then try again. When the calf has started to suck the fingers eagerly, draw the hand slowly down into the milk. Spread the fingers slightly and the calf will draw milk into its mouth between the fingers as it sucks. After it gets several swallows remove the fingers. At this point the calf may continue to drink, or it may raise its head, and the foregoing procedure may have to be repeated several times.

Usually the calf will move around and butt the pail vigorously in its effort to get the milk. To restrain the calf and avoid spilled milk, it may be necessary to back the calf into a corner and straddle the calf before offering it milk (fig. 6). Then if the calf refuses to lower its head into the pail, the head can be forced down gently.

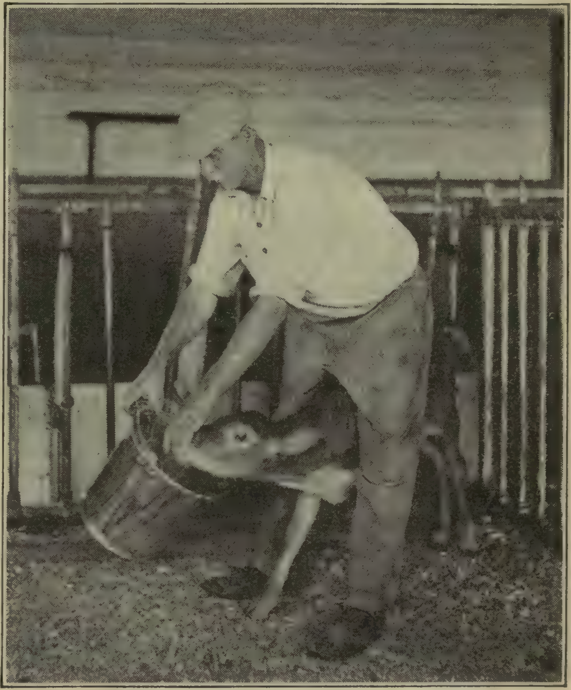


FIGURE 6.—Teaching the calf to drink.

If the calf does not learn to drink at the first feeding, do not feed it again until it is hungry.

FEEDING CALVES DURING THE FIRST 2 TO 4 WEEKS

The proper feeding of the dairy calf during the first month of its life is of the greatest importance. Since its digestive system is easily upset, the calf will thrive better at this time if it is fed sparingly rather than too much. Also, precautions are necessary in hand-feeding that are not required when the calf takes its food in a natural manner.

In order to get a good start, the average strong, vigorous calf should be fed whole milk for at least 2 weeks; then the whole milk may be gradually replaced by fresh skim milk, other milk products, or specially prepared calf meals. If the calf is weak, or if it is especially valuable, feed whole milk 3 or 4 weeks before making any change.

During the first week feed fresh, warm milk from the calf's dam. Afterwards mixed milk from the herd can be used.

If the calf is weak, it may be desirable to feed small quantities of milk three times a day for a week or two, after which twice a day will be sufficient. Strong calves will usually do about as well if fed only twice a day from the start.

QUANTITY OF WHOLE MILK TO FEED

The quantity of whole milk to feed will depend upon the size and condition of the calf. In attempting to grow a good calf, too often the tendency is to feed too much milk at the start. As a consequence the calf gets indigestion and scours, and does not thrive as well as if it had received a smaller quantity. Never feed the strong, vigorous calf more than 1 pound of milk per day for each 10 pounds of live weight, during the first 7 days. Feed small, sick, or weak calves smaller quantities, according to their condition.

Data on the birth weight of dairy calves collected by a number of agricultural experiment stations throughout the United States indicate that the average weight at birth of calves of the principal dairy breeds is approximately as follows: Jerseys, 55 pounds; Guernseys, 65; Ayrshires, 70; Holsteins, 90; and Brown Swiss, 95. The smallest calves weigh considerably less and the largest calves considerably more than these average figures. Male calves weigh a little more than female calves, and purebred Holstein and Brown Swiss calves are heavier on an average than grade calves of these breeds.

The following quantities of milk per day will be sufficient at the start for average-sized, vigorous calves of the different breeds:

	Pounds
Jersey	5
Guernsey	6
Ayrshire	7
Holstein	8
Brown Swiss	8

Large and vigorous calves may be safely fed 1 or 2 pounds per day more than the quantities indicated. Small calves and calves that are weak or sickly should receive smaller quantities, according to their condition. If it is necessary to reduce greatly the quantity of milk fed, the calf may not get sufficient liquid to supply its needs for water. In such cases, add enough warm water to make up for the reduction in the quantity of milk.

To avoid indigestion and scours, feed the calf at regular hours. Carefully regulate the quantity of milk and feed it at a temperature of 90° to 100° F. Use a scale and weigh the milk at each feeding (fig. 7). If a scale is not available, use a pint or quart measure and measure the quantity very closely. For feeding purposes, consider 1 pint as 1 pound, and 1 quart as 2 pounds.

Too rich milk may give the calf indigestion and scours. If the milk tests more than 4 percent butterfat, dilute it with a little warm water or skim milk at each feeding.

ADDING LIMEWATER TO MILK

Until the calf is 3 or 4 weeks old, the addition of one half pint of limewater to the whole milk at each feeding appears to be beneficial. The hand-fed calf drinks milk rapidly, and limewater will help prevent the milk from forming into a hard curd that cannot be readily digested by weak or sickly calves.

Limewater may be made from either unslaked lime (lump lime) or commercial hydrated lime (common plaster lime, usually sold in paper bags). To make limewater from unslaked lime, place a lump about the size of an egg in the bottom of a pail of water. When this has slaked, stir vigorously. When using commercial hydrated lime, stir 2 ounces or so into a bucket of water and mix thoroughly several times at short intervals. In either case allow the lime to settle and use only the clear solution. When this supply is gone, use fresh lime in making up a new batch.

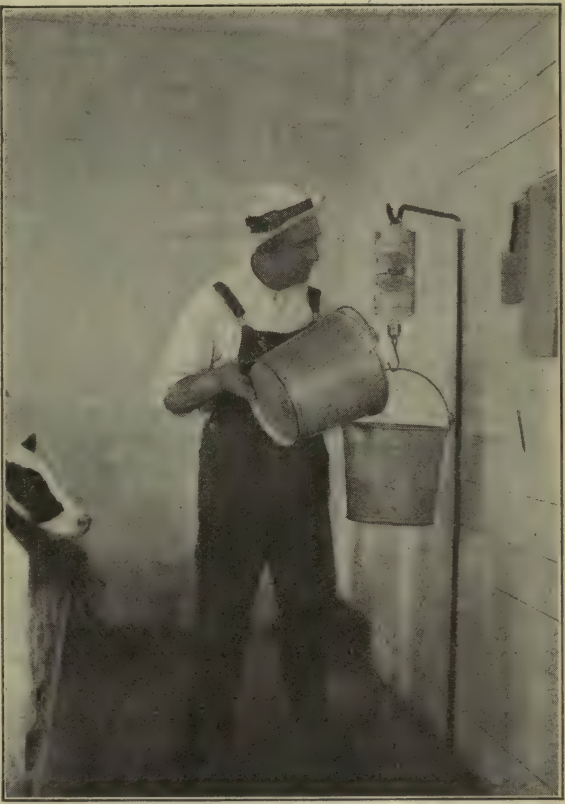


FIGURE 7.—Weighing milk for the calf.

METHOD OF FEEDING AT BELTSVILLE

A large number of Jersey and Holstein calves are raised each year at the experiment station at Beltsville, Md. They are taken from their dams when about 12 hours old and are fed twice a day from the start. Whole milk is fed for the first 30 days, and then a change is gradually made to skim-milk feeding. The quantities of milk fed are as follows:

Jersey calves receive 2½ pounds of whole milk and one half pint of limewater per feed for the first 10 days; 3 pounds of whole milk and one half pint of limewater per feed for the second 10 days; and 4 pounds of whole milk and one half pint of limewater per feed for the third 10 days.

Holstein calves receive 4 pounds of whole milk and one half pint of limewater per feed for the first 10 days; 5 pounds of whole milk and one half pint of limewater per feed for the second 10 days; and 6 pounds of whole milk and one half pint of limewater per feed for the third 10 days.

Calves that are weak or sickly are fed considerably smaller quantities of milk until their condition improves and they are able to digest normal quantities.

FEEDING CALVES FROM 1 TO 6 MONTHS OF AGE

DIFFERENT METHODS OF FEEDING

After the calf has received a good start on whole milk, it will grow and develop satisfactorily on a number of different feeds if their quality is good and feeding conditions are carefully controlled.

A few breeders of dairy cattle continue whole-milk feeding, but whole milk is usually too valuable to feed to calves of this age. Calves do nearly as well on fresh skim milk, and where it is available most calves are raised on this feed. If fresh skim milk is not available, calves can be raised satisfactorily on fresh buttermilk, fresh whey, dried or powdered skim milk, dried buttermilk, and condensed or semisolid buttermilk. With careful feeding the use of any of these products, except possibly whey, will get results nearly equal to those obtained from fresh skim milk. The average chemical composition of normal whole milk, colostrum milk, skim milk, buttermilk, and whey are given in table 1. The calf requires hay of good quality, a suitable grain mixture, and a plentiful supply of pure water at an early age to supplement these feeds.

TABLE 1.—*Average composition of normal whole milk, colostrum milk, skim milk, buttermilk, and whey* [1]

Product	Water	Mineral matter	Protein	Sugar or carbohydrates	Fat
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Normal whole milk	87.0	0.7	3.3	5.0	4.0
Colostrum milk	74.5	1.6	17.6	2.7	3.6
Skim milk	90.5	.7	3.4	5.1	.3
Buttermilk	91.0	.8	3.5	4.2	.5
Whey	93.4	.7	.8	4.8	.3

[1] Missouri Research Bulletin 35, A Study of the Birth Weight of Calves.

Where milk or milk products are not too high in cost it is best to continue feeding them until the calf is about 6 months of age. At this time the calf should be eating large enough quantities of other feeds so that its growth will not be retarded to any appreciable extent.

When the cost of feeding milk or milk products is excessive, they may be gradually discontinued after the calf is 3 months old. Usually such calves will not gain so rapidly at this time as calves fed milk for 6 months.

If the young calf is given a specially prepared calf meal, the use of milk in any form can be gradually discontinued beginning with the third or fourth week, or as soon as the calf starts eating calf meal. The better grades of calf meal contain some form of animal product. For a time calves fed calf meal will not gain so fast or be so thrifty-looking as those fed milk products.

CONTINUING TO FEED WHOLE MILK

On farms where no skim milk or other milk product is available and whole milk is too valuable to feed large calves, after the third or fourth week the calf should be given whole milk in gradually decreasing quantities and be given increasing quantities of good hay and a specially prepared calf meal, fed either dry or as a gruel, until at 6 or 7 weeks of age the calf is getting no milk. The quantity of whole milk to use under this method of feeding is discussed under Specially Prepared Calf Meals.

Dairy calves to be disposed of for veal usually continue to receive whole milk until slaughtered. This is taken up under Feeding Dairy Calves for Veal.

FRESH SKIM MILK

If the calf is doing well, gradually substitute fresh skim milk for whole milk when the animal is 2 to 4 weeks old. Take at least 10 days to make the change, substituting skim milk for whole milk at the rate of about 1 pound a day. Do not increase the total quantity of milk fed while this change is being made. If the calf has scours (diarrhea) the milk is not being properly digested. Delay any further substitution of skim milk for whole milk until this condition disappears. It may be necessary to give the calf a purgative and reduce the quantity of milk fed. The treatment for scours is taken up under Scours from Indigestion.

Feed fresh warm skim milk direct from the separator if possible. If the skim milk is not fed soon after being separated, warm it to about 95° F. before feeding. Feeding dirty milk, or milk alternately sweet and sour or warm and cold, may bring on indigestion and scours. If the feeding is carefully supervised, milk that is uniformly cold or sour can be fed successfully after the calf is 2 to 3 months of age. However, some calves may have a tendency to scour on such milk, and it is best to make a practice of feeding only warm, sweet skim milk. In feeding skim milk, take care to remove the foam as this sometimes causes digestive trouble and bloating.

After changing from whole milk to skim milk, increase the quantity of skim milk fed by 1 pound daily every week or by 2 pounds daily every 2 weeks, until the calf is getting at least 14 pounds a day. After this time the quantity fed depends largely on the quantity of skim milk available. Good calves can be raised on a maximum of 14 pounds of skim milk a day, although some calves can make use of as much as 18 to 20 pounds daily. Skim-milk feeding can be successfully terminated when the calf is 4 months old, if the proper supplements are fed. However, the calf will not grow so rapidly as when skim-milk feeding is continued for a longer period. If skim milk is available, it should be fed until the calf is 6 months old. Where especially good growth and development are desired, skim milk can be fed to advantage until the calf is 8 to 10 months old.

FRESH BUTTERMILK AND FRESH WHEY

Buttermilk or whey to be suitable for calves should be strictly fresh, and should not be diluted by wash water or condensed steam. They should also be pasteurized, and hauled to the farm and fed while still fresh and wholesome. If the above conditions are not met, these feeds will not prove satisfactory for dairy calves.

Fresh buttermilk has practically the same composition as fresh skim milk, but is higher in acid content except possibly when sweet-cream butter is manufactured. If fresh buttermilk is to be fed, do not change from whole milk to fresh buttermilk until the calf is 4 weeks old. Then follow the directions as in feeding fresh skim milk, both as regards quantity and methods of feeding.

As whey lacks most of the protein contained in skim milk, the grain mixture fed with whey should contain more protein than one fed with skim milk (p. 14). Like fresh buttermilk, fresh whey has a higher acid content than fresh skim milk. Do not change from whole milk to whey until the calf is 5 or 6 weeks old; then proceed as in feeding fresh skim milk. While a fair rate of growth can be obtained by feeding fresh whey, the calf will not gain as rapidly as on fresh buttermilk or fresh skim milk under the same conditions of feeding. The addition of a little whole milk or skim milk to whey will make it a better feed.

Both fresh buttermilk and fresh whey are likely to be a little more laxative than fresh skim milk, and more care should be exercised when changing to these feeds than when changing from whole milk to fresh skim milk. In order to avoid digestive disturbances, these feeds should be uniform in quality, and the quantity fed should be increased gradually.

DRIED SKIM MILK, DRIED BUTTERMILK, AND CONDENSED OR SEMISOLID BUTTERMILK

Dried skim milk and dried buttermilk are manufactured from the fresh products by removing most of the water, using heat and either the spray process or the drum or roller process. Feeding trials at a number of agricultural experiment stations show that calves will make satisfactory growth on these milk products, and that products dried by either process may be used. These feeds have a low moisture content. They are shipped in either paper-lined barrels or bags and will keep indefinitely if stored in a dry place.

In the production of condensed or semisolid buttermilk, part of the water is removed, leaving the material in a semisolid or heavy liquid form. Calves do nearly as well on semisolid buttermilk as on dried buttermilk. Condensed buttermilk is shipped in sealed barrels or cans, and will keep indefinitely without loss from mold if an even layer is removed from the entire surface each day.

The calf may be fed dried skim milk reconstituted to the approximate composition of fresh skim milk, beginning at 2 to 4 weeks of age. The feeding of reconstituted buttermilk, made from either dried or condensed buttermilk should be delayed until the calf is 4 weeks old. Gradually change from feeding whole milk to the reconstituted milk product in the same way and using the same quantities as recommended for fresh skim milk (p. 11). The change from whole milk to dried skim milk will have about the same effect on the calf as the change from whole milk to fresh skim milk. Dried and semisolid buttermilk are likely to be a little more laxative than fresh or dried skim milk, and more care should be exercised when changing from whole milk to reconstituted buttermilk than when changing from whole milk to skim milk.

To prepare the dried skim milk or dried buttermilk for feeding the young calf, mix 1 part of the dried product to a smooth paste with an equal part by weight of warm water. When the lumps have all been broken up, add 8 more parts by weight of warm water and stir thoroughly. To prepare the condensed buttermilk for feeding, add 3 parts by weight of warm water and stir until well mixed. For best results, mix with the same proportion of water from day to day and feed at a temperature of about 95° F. Mix only enough at one time for one feeding.

If these products do not cost too much, feed the same quantities as for fresh skim milk until the calf is 4 to 6 months old. If the cost of such products is too high, the amount fed per day can be gradually reduced, beginning at 6 or 7 weeks of age, and the calf fed a grain mixture containing 25 percent of dried skim milk or dried buttermilk until it is 3 to 4 months old.

SPECIALLY PREPARED CALF MEALS

If skim milk or other milk products are scarce or high priced, whole milk may be gradually replaced by a specially prepared calf meal. Although this is not quite as satisfactory as feeding fresh or dried skim milk, the results will be fairly satisfactory if a good calf meal is properly fed.

Several ready-mixed calf meals are on the market. The best ones contain an animal product, preferably some sort of dried milk. Satisfactory calf meals can be mixed at home if the necessary ingredients can be obtained.

The following mixture has been devised at the Beltsville Experiment Station where it has given satisfactory results:

Fifty parts of finely ground corn, 15 parts of linseed meal, 15 parts of finely ground rolled oats, 10 parts of dried blood flour, 10 parts of dried skim milk, and 1 part of salt. The composition of this meal is not materially different from that of other calf meals in satisfactory use at several experiment stations.

Formerly, calf meals were fed wet in the form of a gruel. This method of feeding requires more labor and greater precautions to prevent scours than is required for skim milk. Recent experiments have shown that calves receiving dry calf meal can be raised with less labor and trouble than when the meal is fed wet.

Specially prepared calf meals are milk substitutes. However, they cannot take the place of milk during the first few weeks of the calf's life, as the calf must have milk at this time in order to thrive. While some experiments have shown that calves can be raised on calf meals with no milk after 30 days of age, better results will be obtained if the calf is fed limited quantities of milk for a longer period.

The following directions for feeding calf meal apply to both commercial meals and those mixed at home, and are made on the basis of feeding limited quantities of whole milk, in addition to meal, until the calf is 50 or 60 days of age, depending on the breed.

Feed Holstein and Brown Swiss calves 8 to 10 pounds of whole milk a day until they are 10 days old, then 8 pounds a day for the next 10 days, then 6 pounds for the next 10 days, then 4 pounds for 10 days, and so on until at 50 days of age the calf will be getting no milk.

Feed Jerseys 5, Guernseys 6, and Ayrshires 7 pounds of whole milk a day for the first 10 days, then 8 pounds for the next 20 days, then 6 pounds for 10 days, and so on until at 60 days of age the calf will be getting no milk.

When the calf is 2 or 3 weeks old, start feeding it small quantities of a grain mixture consisting of whole or coarsely ground grain and a good quality of hay.

Begin the feeding of the calf meal when the calf is 20 days old. If the meal is fed dry, give the calf all it will eat up to 2 pounds a day, adding 5 or 10 percent by weight of whole corn to the meal to prevent too rapid eating.

If the meal is fed wet, mix it with six times its weight of warm water and start with about 0.4 pound of dry meal a day. Increase the amount by about 0.2 pound dry weight every 4 days, so that at the end of 50 or 60 days the calf will be getting 2 pounds of meal a day.

When the calf is 3 months old the dry or wet calf meal may be discontinued gradually, and the quantity of grain increased accordingly.

By following this method of feeding, only about 300 pounds of whole milk will be required to raise a calf. Experience has shown that health cannot be maintained and satisfactory growth made on much less than this quantity.

HAY, GRAIN, AND SILAGE

After the calf is 2 to 3 weeks old, it requries other feeds in addition to milk in order to grow and develop properly. At the beginning of the third week, give it small quantities of hay and grain. Feed the most palatable hay on hand. Early cut clover, alfalfa, or mixed hay cured so as to retain its green color and most of its leaves is high in vitamins and assimilable minerals, and is best suited for calves. Place the hay in a rack where the calf can reach the hay but cannot soil it. Young calves fed alfalfa hay that is extra leafy may eat enough to cause scours. It is better to limit the quantity of such hay fed until the calves have become accustomed to it.

The grain mixture used should be palatable, have no bad effect on the digestive system, and supply the required nutrients. Home-grown grains such as corn and oats and purchased feeds such as wheat bran and linseed meal are good calf feeds. Young calves show a preference for whole grains and will gain as fast or a little faster on whole grain than they would on ground grain. When teaching the calf to eat grain, place a small handful of coarsely ground corn or mixed corn and oats in the bottom of the pail after the calf has finished drinking its milk. After the calf has learned to eat grain readily, feed whole or coarsely ground grain to balance the ration. Feed older calves grain that has been medium or coarsely ground. The following grain mixtures are suitable for calves.

MIXTURES CONTAINING 10 TO 12 PERCENT TOTAL PROTEIN

For calves fed milk or milk products other than whey and for weaned calves and heifers on good pasture or receiving legume hay alone:

A	B		C		D	
		Pounds		Pounds		Pounds
Oats alone.	Corn	10	Corn	30	Corn	30
	Oats	10	Wheat bran	10	Oats	10
					Wheat bran	10

MIXTURES CONTAINING 14 TO 16 PERCENT TOTAL PROTEIN

For calves fed whey or a calf meal and for weaned calves and heifers receiving a legume hay and silage or mixed hay alone:

E		F		G	
	Pounds		Pounds		Pounds
Corn	30	Corn	30	Corn	30
Oats	10	Wheat bran	10	Oats	10
Linseed meal	10	Linseed meal	10	Wheat bran	10
				Linseed meal	10

MIXTURES CONTAINING 18 TO 20 PERCENT TOTAL PROTEIN

For weaned calves and heifers receiving mixed hay and silage or grass hay alone or with silage:

H	Pounds	I	Pounds	J	Pounds
Corn	10	Corn	20	Corn	10
Oats	20	Wheat bran	10	Oats	10
Linseed meal	10	Linseed meal	10	Wheat bran	10
				Linseed meal	10

In these grain rations, barley, kafir, or hominy feed may replace part or all of the corn. Calves over 6 months of age may be fed cottonseed meal instead of linseed meal.

A calf 2 weeks old will eat only a small handful of grain per day. Increase the amount gradually until the calf gets about half a pound daily at 4 weeks of age, a pound at 6 weeks, 1½ pounds at 8 weeks, and 2 pounds at 10 weeks to 3 months of age. If the calf is given liberal quantities of some milk product up to the age of 6 months, 2 pounds of grain per day may be sufficient to keep it growing well. If the use of milk products is discontinued before 6 months, it will be necessary to feed 3 or even 4 pounds of grain a day (including any calf meal).

Silage is not a satisfactory feed for the young calf, as its addition to a ration of milk, hay, and grain may cause digestive disturbances and scours. However, it makes a good supplemental feed after the calf has reached 3 months of age. Silage should be fed only in limited quantities in addition to hay of good quality, as it is desirable that the calf eat as much hay as possible. One to two pounds of silage per day is enough for the 3-month-old calf. Gradually increase the quantity at the rate of 1 pound a day for each month of increase in the calf's age. Take care not to feed any moldy or frozen silage, and remove any uneaten silage from the manger each day.

PASTURE

Fall and early winter calves will make good growth on pasture the following spring and summer if the pasturage is supplemented by skim milk and grain, or grain alone when the calves have reached 4 to 6 months of age. Spring calves will not be old enough to make extensive use of pasture until late summer and fall, when pasturage is often poor. For this reason it is best to keep spring and summer calves off pasture, except to exercise, until the following season. Besides, the addition of green grass to the ration of milk and grain may cause digestive disturbance and scours in calves under 2 months of age. Young calves will do better in hot weather when kept in well-ventilated, shady quarters during the day than when allowed to roam in a pasture or open lot in the sun.

WATER

The importance of water for young calves is not always fully realized. The calf should be supplied regularly with fresh, pure water. It should not be permitted to suffer from a lack of water, especially during warm weather, or when it is being fed a limited quantity of milk. Soon after the calf has learned to drink, it can be readily induced to drink water from its pail immediately after finishing its milk. At first the calf should be offered water warmed to about body temperature. Calves old enough to run together should have a supply of drinking water available in a conveniently located tank or water trough.

The extent to which a lack of water may affect the growth and development of calves is indicated by an experiment conducted at the Wisconsin Experiment Station during warm weather. Two groups of calves each received 14 pounds of skim milk per day per calf and all the hay and grain they would eat. The calves in the group given water consumed somewhat more water than milk. They also ate twice as much hay, nearly one third more grain, and gained 0.44 pound more per day than the calves in the group receiving no water.

MINERALS

Salt should be provided as soon as the calf is old enough to eat hay and grain. One pound of salt may be added to each 100 pounds of the grain mixture or the calf meal. Salt should also be placed in a conveniently located box where the calf can have access to it as desired.

The ration of the calf receiving a well-cured legume hay, grass hay, or mixed legume and grass hay, and a suitable grain mixture, along with salt, will usually be adequate in minerals. Experiments at a number of agricultural experiment stations have shown that under these conditions no benefit is derived from the addition of supplemental minerals to the growing animal's ration.

However, if hays of poor quality are fed, there may be a shortage of calcium in the ration. Also, in localities where there is a shortage of phosphorus in the soil, rations consisting of home-grown feeds may be deficient in this mineral.

Wheat bran and linseed meal are high in phosphorus, and the inclusion of one of these feeds in the grain mixture will take care of any phosphorus deficiency. Bone meal is a source of both calcium and phosphorus, and is a suitable mineral supplement for use where these minerals are deficient in the ration. A special grade of feeding bone meal or poultry bone meal is suitable for this purpose. The bone meal can be added to the grain mixture at the rate of 1 pound to each 100 pounds of grain, or it can be mixed with salt at the rate of 3 or 4 parts of bone meal to 1 part of salt and placed in a box alongside the salt box where the calves and heifers can have access to it as desired. Many commercial dairy feeds and calf meals contain from 1 to 2 percent of bone meal.

In regions where calves are born with big neck or goiter, iodine may be deficient in the ration. However, the supplemental use of iodine in the ration is necessary only in feeding pregnant cows and heifers, so that the calf will be normal at birth. Iodine may be given effectively by mixing with the feed of the pregnant cow once each week a tablespoonful of a 5-percent solution of potassium or sodium iodide.

VITAMINS

Vitamins are certain substances other than protein, carbohydrates, fats, and minerals that occur in minute quantities in natural food substances and are essential to the life and health of animals. Those vitamins studied have been named A, B, C, D, E, and G. Vitamin B is sometimes called B_1 or F, and vitamin G is sometimes called B_2. Both these vitamins were formerly called B.

Of these six vitamins, A is the one most likely to be deficient in the calf's ration, according to the information so far obtained. Vitamin A has to do with growth and resistance to infection. Carotin, one of the yellow pigments of plants from which vitamin A is formed in the animal body, occurs in close association with the green coloring matter of pasture plants and other green forage, and also with the green coloring matter of cured roughages. In carrots and yellow corn it occurs in dissociation from the green color. The vitamin A content of yellow corn, however, is very low in comparison to that of carrots and green roughages. As a rule, the greener the color of the roughage the greater its content of carotin.

Vitamin D or some unidentified property of pasture grass, or of other green forage, or of hay cured with much of its natural green color, is useful in promoting the assimilation of calcium or lime, and the retention of calcium in the body.

Feeding experiments with dairy cattle at the Beltsville Experiment Station show that cows fed for extended periods on a ration deficient in vitamin A give birth to weak, dead, or immature calves; that the vitamin A content of milk produced by cows on such rations is also greatly reduced; and that calves fed the milk from cows that have received a vitamin A deficient ration for some time will cease to grow and will soon die if fed a poor grade of hay low in vitamin A, but if given supplementary feeds rich in vitamin A or carotin they will survive. Whether this is due entirely to a deficiency of vitamin A has not been determined definitely.

In these experiments it was found possible to prevent this condition, or bring the calf back to normal health and rate of gain in body weight by the addition of 20 cc (a little more than 1 tablespoonful) of cod-liver oil daily to the ration.

When the dairy calf's ration is deficient in vitamin D, sufficient calcium or lime may not be deposited in the bones, and a rachitic condition known as rickets may develop, especially during the winter months. Experimental work has also shown cod-liver oil to be effective in preventing or curing this condition.

In the light of present knowledge it appears that when a normal healthy calf is fed a ration adequate in quantity and in the vitamins A and D, no benefit will be derived from cod-liver oil. Since winter milk does not ordinarily contain as much of vitamins A and D as summer milk, and because the young calf consumes hay in very limited quantities, it may be desirable to give cod-liver oil to calves up to 2 or 3 months of age during the winter feeding period, if the calf does not seem to be thrifty or to be gaining as well as it should.

In feeding the calf, provide as much of vitamins A and D in the ration as possible by feeding it milk in summer from cows receiving pasture or green cut feed, and in winter, early cut hay cured so as to retain its natural green color and most of its leaves. Beginning at an early age, feed the calf all the hay of this quality it will eat in addition to the milk.

FEEDING HEIFERS FROM 6 TO 12 MONTHS OF AGE

By the time the calf has reached 6 months of age, the feeding of skim milk or specially prepared calf meals has usually been discontinued. The heifer should have an abundance of other feeds so that she will continue to gain normally. Supply plenty of roughage at all times in the form of good pasture in summer, and hay and silage in winter.

Feed enough grain in addition so that the heifer will remain in a good state of flesh.

In summer green pastures furnish well-balanced feed for growth. Usually green pasture plants are high in protein and minerals. Furthermore, the minerals in green pasture plants are more easily and completely taken up by the body than are the minerals in any other feeds. A heifer from 6 to 12 months of age may require a little grain in addition to pasture, even when the pasture is good. Early in the spring, when she is first put on pasture, and late in the summer, when pastures are short, some additional roughage in the form of hay or silage will also be required.

During the winter feeding season, give the 6- to 12-month-old heifer all the good hay she will eat, 5 to 15 pounds of silage per day, if available, and enough grain to keep her growing normally.

Evidence is accumulating from experiments completed, and others underway, to indicate that a good rate of growth can be made on a ration consisting entirely of roughage, starting at as early an age as 6 months, when the roughage fed is of good quality.

In feeding grain, a safe rule to follow is to feed the heifer receiving roughage of only fair or average quality about one half pound of grain per day for each 100 pounds of body weight. If the hay is a legume of good quality, feed less grain. A grain mixture containing 10 to 12 percent of total protein will be suitable for heifers on good pasture or receiving legume roughages, for example—alfalfa, clover, vetch, cowpea, field-pea, and soybean hays. If some of the roughage is in the form of nonlegumes—for example, prairie hay, timothy hay, corn stover or corn silage—the grain mixture should contain 14 to 16 percent of total protein. When the roughage consists entirely of nonlegumes, excepting grasses cut at an immature stage of growth, a grain mixture containing 18 to 20 percent of total protein will be necessary to furnish sufficient protein in the ration. Suitable grain mixtures are given on pages 14 and 15.

When the heifer receives green pasture, hay cured with a green color, and wheat bran as part of the grain ration, her requirements for minerals and vitamins will be provided for if she gets enough feed.

FEEDING HEIFERS FROM 1 TO 2 YEARS OF AGE

A heifer from 1 to 2 years old needs the same kind of feed and about the same kind of care as a heifer 6 to 12 months old, but if fed plenty of roughage of good quality, can make good growth with less grain.

When on abundant good pasture (fig. 8), additional feed will not be necessary for good growth. It will be necessary to supplement early spring and short summer pastures by feeding hay or silage (fig. 9), and in some cases a little grain.

During the winter feeding period, give her all the good hay she will eat. If silage is available, and relatively cheaper than hay, feed as much as 15 to 25 pounds per day. In addition, feed her grain according to her condition. If a good-quality alfalfa hay and corn silage are fed liberally, the heifer will make good growth with little or no grain. If the hay is partly nonlegume, or if the roughage is low in quality, more grain will be required. Usually from one third to one half of a pound of grain daily for each 100 pounds of body weight will be sufficient. The heifer should be in good flesh at calving time, but not excessively fat.

EFFECT OF DIFFERENT METHODS OF FEEDING ON THE GROWTH OF DAIRY HEIFERS

The effects of different methods of feeding on the growth of dairy heifers is shown in table 2, which gives the average live weights by months from birth to 2 years of age, for Holstein heifers raised at the Federal dairy experiment stations at Huntley, Mont., and Ardmore, S.Dak., and for both Holstein and Jersey heifers raised at Beltsville, Md.

FIGURE 8.—Pastures should furnish shade and water as well as good grazing.

FIGURE 9.—Heifers on short pasture need supplementary feed.

TABLE 2.—*Average body weights by months from birth to 2 years of age, for Holstein heifers at the Huntley (Mont.), Ardmore (S.Dak.), and Beltsville (Md.) Experiment Stations, and for Jersey heifers at the Beltsville Station*

Age	Holstein			Jersey
	Huntley [1]	Ardmore [2]	Beltsville [3]	Beltsville [4]
	Pounds	*Pounds*	*Pounds*	*Pounds*
At birth	87	90	97	51
1 month	126	132	121	72
2 months	174	184	155	92
3 months	231	238	197	128
4 months	294	294	253	168
5 months	361	342	303	211
6 months	425	403	360	257
7 months	488	449	407	299
8 months	544	485	460	335
9 months	594	515	507	372
10 months	634	537	553	404
11 months	680	560	586	436
12 months	721	590	627	466
13 months	750	628	662	490
14 months	786	659	708	515
15 months	807	689	745	538
16 months	842	707	777	562
17 months	870	730	812	583
18 months	905	752	840	603
19 months	936	787	881	627
20 months	969	824	912	644
21 months	990	860	944	666
22 months	1,016	894	982	693
23 months	1,050	934	1,016	722
24 months	1,071	973	1,057	743

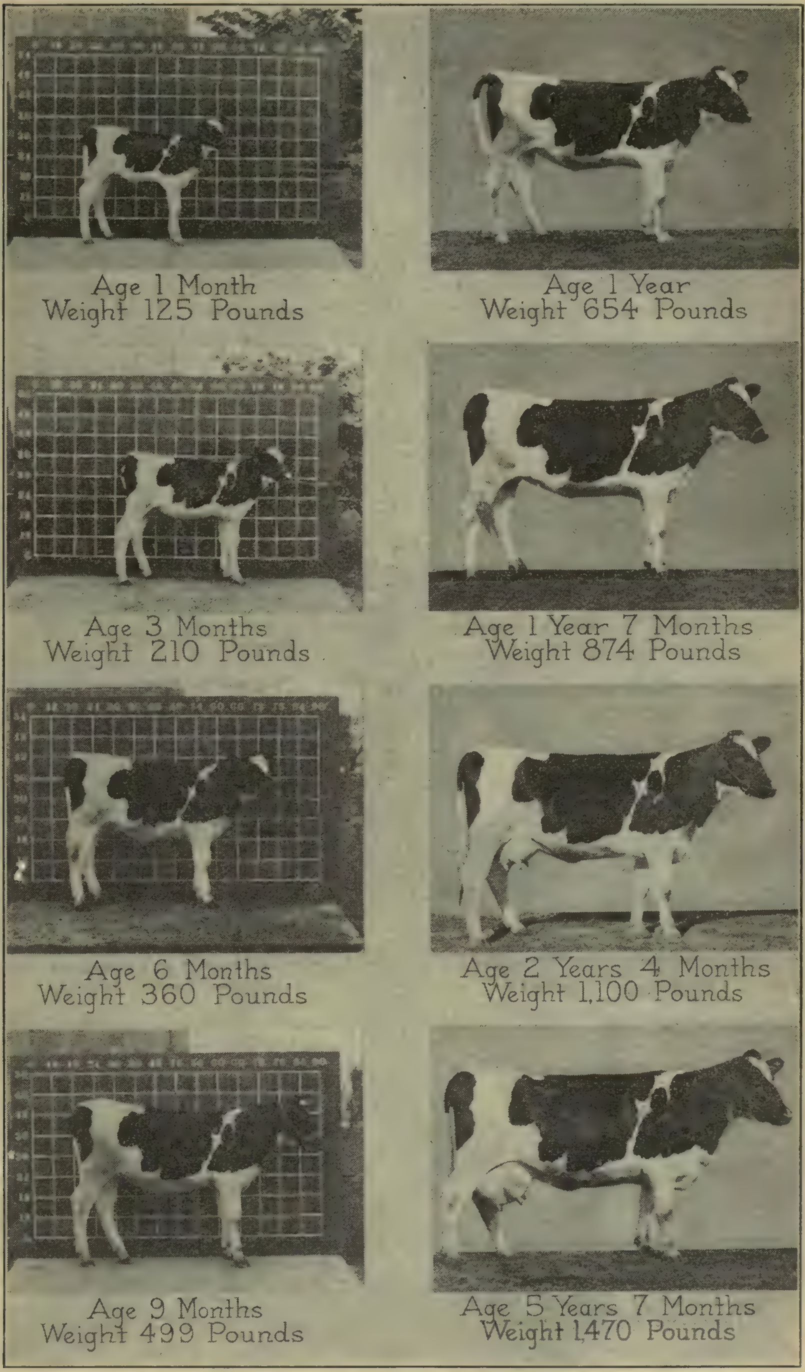
[1] Average of 16 heifers.
[2] Average of 17 heifers.
[3] Average of 27 heifers.
[4] Average of 35 heifers.

At Huntley, Mont., the heifers were fed whole milk for about 1 month, and then skim milk, together with grain and alfalfa hay, until they were 9 months old. After the age of 9 months, they received alfalfa hay and corn silage without grain. They were also on irrigated pasture about 2 months during the second year.

At Ardmore, S.Dak., the heifers were fed whole milk about 1 month, and then skim milk, together with grain, alfalfa hay, and corn silage, until they were 6 months old. After the sixth month of age, they received hay, corn silage, and grain in winter, and were on native unirrigated pasture in summer without any other feed, during both the first and second years. The hay fed was about two thirds alfalfa and one third barley, millet, bromegrass and sweetclover hays combined. The grain consisted entirely of a mixture of home-grown grains. The quantity of grain fed did not exceed 2 pounds per head per day, except that some of the heifers received extra grain during one winter when there was a shortage of roughage feeds.

At Beltsville, the method of feeding used for both Holstein and Jersey heifers was as follows: They received whole milk until they were about 1 month of age; then had skim milk in moderate quantities, together with grain, alfalfa hay, and corn silage, until they were 6 months old. After the sixth month they received grain, hay, and corn silage. During the summer of the second year, most of the heifers were on pasture and also had grain, except for a short time when the pasture was at its best. The rate of grain feeding was increased to a maximum of about 4 pounds per day for Holstein heifers and 3 pounds per day for Jersey heifers.

The rate of growth and general appearance of a Holstein heifer and a Jersey heifer from 1 month to 2 years of age and at maturity, raised



Age 1 Month
Weight 125 Pounds

Age 3 Months
Weight 210 Pounds

Age 6 Months
Weight 360 Pounds

Age 9 Months
Weight 499 Pounds

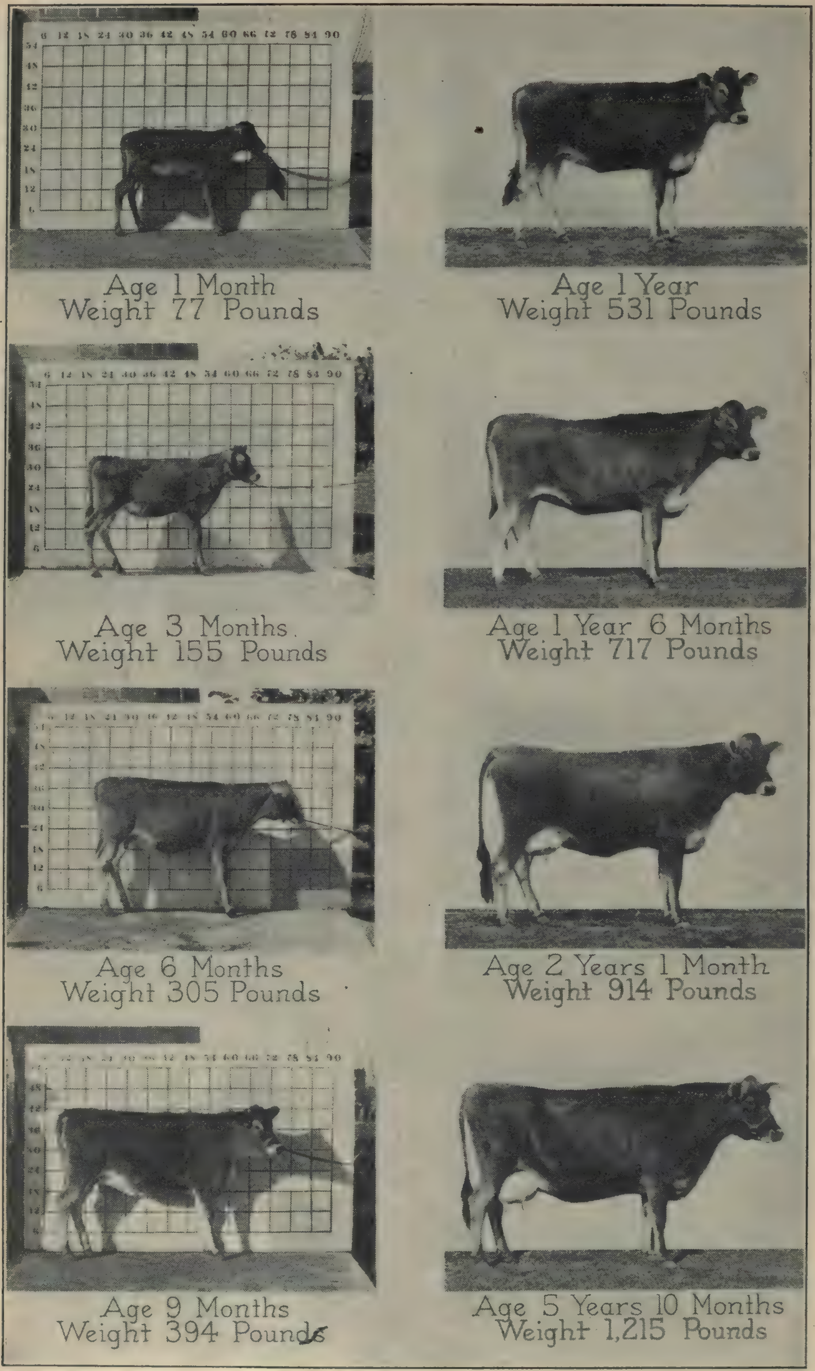
Age 1 Year
Weight 654 Pounds

Age 1 Year 7 Months
Weight 874 Pounds

Age 2 Years 4 Months
Weight 1,100 Pounds

Age 5 Years 7 Months
Weight 1,470 Pounds

FIGURE 10.—Pictorial record of the growth of a Holstein female at the ages stated, in the experimental breeding herd of the Bureau of Dairy Industry at Beltsville, Md. (Mature-age record, 21,516.1 pounds of milk and 727.4 pounds of butterfat.)



Age 1 Month
Weight 77 Pounds

Age 3 Months
Weight 155 Pounds

Age 6 Months
Weight 305 Pounds

Age 9 Months
Weight 394 Pounds

Age 1 Year
Weight 531 Pounds

Age 1 Year 6 Months
Weight 717 Pounds

Age 2 Years 1 Month
Weight 914 Pounds

Age 5 Years 10 Months
Weight 1,215 Pounds

FIGURE 11.—Pictorial record of growth of a Jersey female at the ages stated, in the experimental breeding herd of the Bureau of Dairy Industry at Beltsville, Md. (Mature-age record, 12,903.0 pounds of milk and 763.99 pounds of butterfat.)

by this method of feeding in the experimental breeding herd at Beltsville are shown in figures 10 and 11. The Jersey heifer is larger than the average of the Beltsville Jersey heifers as shown in table 2.

Of the three groups of Holstein heifers, two showed very little difference in the average body weight at 2 years of age, while the third averaged somewhat less in weight. The Holstein heifers at Ardmore weighed on an average 43 pounds more at 6 months, 37 pounds less at 1 year, 88 pounds less at 18 months, and 83 pounds less at 2 years of age, than the Holsteins at Beltsville. The Holstein heifers at Huntley, as compared with those at Beltsville, weighed 65 pounds more at 6 months, 88 pounds more at 9 months, 94 pounds more at 12 months, 61 pounds more at 18 months, and 14 pounds more at 2 years of age. The alfalfa hay fed to the heifers at Huntley was probably of higher average quality than the hay fed to the heifers at Ardmore and Beltsville.

QUANTITIES OF FEED CONSUMED BY DAIRY HEIFERS FROM BIRTH TO 2 YEARS OF AGE

In an experiment at Beltsville to determine the feed requirements of growing dairy heifers, 5 Holstein and 5 Jersey heifers were fed from birth to 2 years of age similarly to the other heifers at Beltsville, except that they received no pasture. These 10 heifers were so fed that they would gain rapidly but would not be excessively fat. They were raised without pasture because an accurate record could then be made of all the feed that they consumed. Their average body weights at 2 years of age were about the same as the averages for the other Holstein and Jersey heifers at Beltsville given in table 2. The monthly body weights, different ages, and total feed consumption to 2 years of age, are shown in table 3.

When available, good pasture could be used to replace all the roughage for heifers from 6 to 12 months of age, and to replace both roughage and grain for heifers over 1 year of age. When pastures begin to get short, heifers will require grain and later on some roughage also, to keep them gaining as rapidly as the heifers in this experiment.

TABLE 3.—*Feed consumed and gains made by Holstein and Jersey heifers from birth to 2 years of age* [1]

[Average of 5 heifers each]

Year and 30-day period	Holstein						Jersey					
	Whole milk	Skim milk	Grain	Alfalfa hay	Corn silage	Weight at end of month or period	Whole milk	Skim milk	Grain	Alfalfa hay	Corn silage	Weight at end of month or period
First year:	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
At birth	-----	-----	-----	-----	-----	103	-----	-----	-----	-----	-----	54
1	223.0	20.8	1.7	1.9	1.5	121	197.6	44.6	0.5	0.8	0.4	73
2	16.7	324.5	20.5	19.3	23.8	151	1.5	286.0	7.6	10.3	8.6	95
3	0.0	402.2	53.9	36.0	71.6	197	0.0	344.7	28.4	24.6	32.6	127
4	-----	402.2	76.2	55.8	118.4	251	-----	343.8	56.9	39.0	75.0	166
5	-----	402.2	87.4	70.1	180.6	308	-----	344.7	75.9	61.1	116.6	211
6	-----	399.5	87.9	70.4	234.5	363	-----	344.7	86.5	75.2	169.4	256
7	-----	0.0	89.1	79.7	334.0	408	-----	1.1	89.1	80.3	271.3	300
8	-----	-----	89.1	87.0	418.5	450	-----	0.0	88.9	84.1	353.6	336
9	-----	-----	89.1	89.6	455.9	496	-----	-----	89.1	87.3	390.3	375
10	-----	-----	93.9	89.6	517.2	545	-----	-----	89.1	87.4	427.4	406
11	-----	-----	94.8	97.0	576.8	582	-----	-----	89.1	88.7	460.4	436
12	-----	-----	92.7	110.6	615.0	624	-----	-----	89.0	88.0	483.6	468
Last 5 days only	-----	-----	15.5	18.5	105.5	-----	-----	-----	14.9	14.6	83.3	-----
Total	239.7	1,951.4	891.8	825.5	3,653.3	624	199.1	1,709.6	805.0	741.4	2,872.5	468
Second year:												
13	-----	-----	120.0	136.8	516.2	656	-----	-----	88.3	97.4	298.3	490
14	-----	-----	111.9	135.1	565.1	695	-----	-----	89.1	112.4	301.9	516
15	-----	-----	106.9	136.6	606.5	735	-----	-----	89.1	115.2	330.6	538
16	-----	-----	106.9	142.8	601.4	771	-----	-----	89.1	119.2	364.7	562
17	-----	-----	106.2	149.6	621.6	797	-----	-----	88.9	116.0	423.6	586
18	-----	-----	106.9	148.8	673.9	829	-----	-----	89.1	119.0	457.4	606
19	-----	-----	106.9	148.6	697.2	866	-----	-----	89.1	118.6	502.0	625
20	-----	-----	101.0	144.0	680.9	898	-----	-----	89.1	118.2	520.4	645
21	-----	-----	95.0	148.8	717.6	933	-----	-----	89.1	118.2	534.2	672
22	-----	-----	95.0	148.2	759.0	977	-----	-----	89.1	118.6	540.8	699
23	-----	-----	95.0	136.6	745.0	1,019	-----	-----	89.1	119.6	565.0	728
24	-----	-----	93.5	143.2	735.4	1,069	-----	-----	88.9	119.0	553.4	752
Last 5 days only	-----	-----	14.9	24.8	123.0	-----	-----	-----	14.9	20.0	87.0	-----
Total	-----	-----	1,260.1	1,743.9	8,042.8	1,069	-----	-----	1,082.9	1,411.4	5,479.3	752
Total	239.7	1,951.4	2,151.9	2,569.4	11,696.1	1,069	199.1	1,709.6	1,887.9	2,152.8	8,351.8	752

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[1] From unpublished reports of experiments by H. T. Converse, on the feed requirements for growth in dairy cattle.

QUARTERS

When the heifer is not on pasture she requires dry, well-bedded, well-ventilated quarters, and a suitable place to exercise. These can be provided by a pen in a barn, or an outside shed open to the south, with access to a yard that is large enough to allow her to take plenty of exercise. Feed mangers and boxes should be kept clean and sanitary. As far as practicable, heifers of about the same age should be kept together and separate from those older or younger. On farms where large numbers of young stock are raised, the calves and heifers are often housed in a barn built especially for that purpose.

AGE FOR BREEDING

The age to breed depends on the growth and development of the heifer. Since she will not yield any income until she has freshened, she should be fed liberally in order that she may be bred to freshen at 2 years of age or soon thereafter. As the calf is carried about 280 days, the well-grown heifer should be bred when 15 to 18 months old. At Beltsville good results have been obtained by having well-grown

Jersey and Holstein heifers freshen soon after 2 years of age. If the heifer is not undersized, nothing is gained by breeding for freshening at a later date. The breeding of heifers that have not made good growth, however, should be delayed somewhat, since too early calving under such conditions may result in smaller than average cows at maturity.

HANDLING THE HEIFER

Kindness in the care of the heifer will make her easier to handle when she enters the milking herd. Teach her to lead at an early age. Stall or house her with the milking herd a month or so before she is due to freshen. If possible, give her the stall she is to occupy after calving. Handle her daily during this period, in a quiet, gentle manner that will gain her confidence. After freshening, milk her carefully and quietly so that she will not get excited. The development of a nervous condition at this time may cause the heifer to form the habit of kicking or holding up her milk.

FEEDING AND MANAGEMENT OF THE YOUNG BULL

The feeding and management of bull calves being raised for breeding purposes is at the start much the same as that for heifers. Bull calves are usually a little larger at birth than heifers and usually grow a little faster.

After young bulls have reached 4 months of age they should be kept separately from young heifers.

Further information with regard to the feeding and management of dairy bulls is contained in Farmers' Bulletin 1412, Care and Management of Dairy Bulls.

FEEDING DAIRY CALVES FOR VEAL

Dairy calves not raised for breeding purposes are sometimes marketed as veal. Calves fed for veal are usually marketed between 3 weeks and 3 months of age, the majority being sold between 4 and 8 weeks of age. Detailed information on classes of veal calves is given in Department of Agriculture Circular 28, Market Classes and Grades of Calves and Vealers. Vealers weighing 110 pounds or less are classified as lightweight, those weighing from 110 to 180 pounds as medium weight, and those weighing over 180 pounds as heavyweight. Each weight division is further classified into several grades on the basis of conformation, finish or degree and smoothness of fleshing and fat, and quality of the meat. When properly finished, the calf that is blocky and compact in conformation will dress out a larger percentage of the high-priced cuts than the calf that is angular and rangy. Consequently it commands a higher market price. Vealers of medium weight usually bring a higher price than either lightweight or heavyweight vealers.

Whole-milk feeding produces the best grade of veal. Where the calf receives grain and hay in addition, these should be fed in very limited amounts. Approximately 10 pounds of whole milk is required to produce 1 pound of gain in live weight. In feeding calves for veal, during the first week give about 7 pounds of whole milk per day to the 60- to 70-pound calf, 8 pounds to the 70- to 80-pound calf, 9 pounds to the 80- to 90-pound calf, and 10 pounds to the 90- to 100-pound calf. After the calf is a week old, increase the quantity of whole milk gradually until a good-sized, vigorous calf is receiving from 16 to 20 pounds or more per day before it is marketed. Calves will fatten more rapidly if fed three times daily and confined so that they get little exercise.

Unless veal is high in price as compared to milk, the value of 10 pounds of whole milk will usually exceed the value of the 1 pound of gain that it produces. Any profit to be made will come, therefore, not from the gain in weight but from the value of the initial or birth weight of the calf. For this reason, profits can only be expected from the feeding for veal of the calf that is large at birth and blocky and compact in conformation. The calf should be fed until it attains a high state of flesh, as thin or inferior calves will not bring a good market price. On the other hand, the calf should be marketed as soon as it reaches the proper condition, since the continued feeding of whole milk will not increase the selling price per pound and will lessen the profit to be made from it.

PREVENTING HORNS

The development of horns can be easily prevented by the use of caustic soda or caustic potash. This material is usually used in the stick form, which is procurable in most drug stores or from dairy-supply houses. Caustic paste is also suitable for this purpose, and is a little easier to apply than stick caustic.

The best time to apply caustic is when the calf is from 4 to 10 days old. At this age the undeveloped horn or button is not attached to the skull and appears more as part of the skin. Growing horns can also be successfully treated with caustic up to the age of 2 or 3 months. The horns of older calves require more caustic, and are more bother to treat.

Before applying the caustic, clip off the hair from around the horn buttons, and apply vaseline to the surrounding area to prevent the caustic accidentally coming in contact with it and causing severe burns.

To apply stick caustic, wrap the stick in paper with one end exposed, or slip it part way into a small rubber tube. Slightly moisten the exposed end with water and rub each horn button alternately, making a raw spot about the size of a nickel. Do not continue rubbing until these spots bleed; merely take the outer skin off of the horn buttons. In treating growing horns, do not treat the tip but make a raw ring completely around the base of the horn where it joins the skin, by rubbing with the stick of caustic. The horn grows from the skin at its base, and destroying this tissue will stop the development of the horn. Do not cut off the horn with a knife, as this causes bleeding which will wash off the caustic. In applying the caustic, use only a minimum of water so that the caustic will not run down the calf's head. The method of applying stick caustic to prevent the growth of horns is illustrated in figure 12.

When using caustic paste, clip only the hair immediately over the horns as the surrounding hair will help to hold the paste in place. Spread a quantity about the size and thickness of a nickel on each horn button. In treating growing horns make a raw ring around the base of the horn where it joins the skin, by rubbing with sandpaper or an ordinary file, but do not draw blood. Then apply the caustic paste to this ring, using a little more than for younger calves. Caustic paste is irritating in action, and the calf will attempt to rub it off, or scratch it off with a hind foot. To prevent this, confine the calf in a close-fitting stanchion during the operation and for a half hour afterwards. If the stanchion does not fit the neck closely the calf is likely to pull back until its ears touch the caustic applied to the buttons, thus causing severe burns.

After treating the horns with caustic, protect the calf from rain for a day or so.

Caustic absorbs moisture from the air and deteriorates rapidly when kept in an open container. When not in use it should be kept in a small glass jar or bottle tightly closed by a rubber stopper.

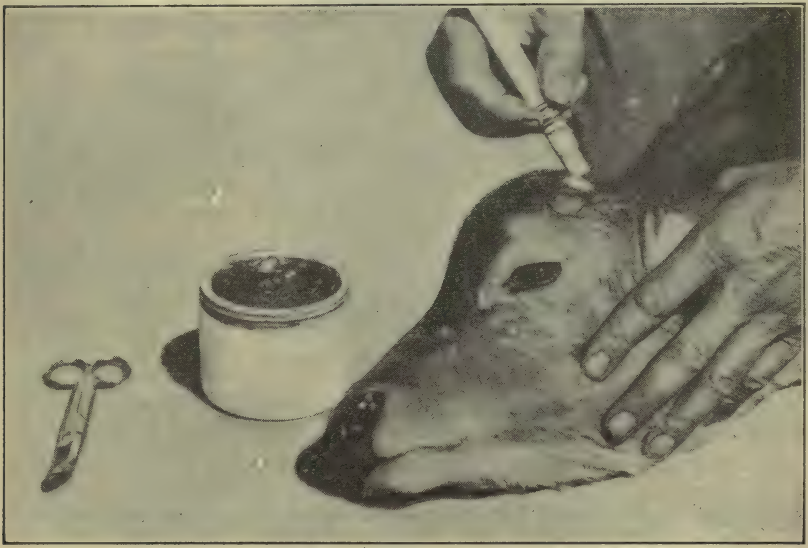

FIGURE 12.—Applying stick caustic to prevent the growth of horns.

MARKING CALVES FOR IDENTIFICATION

It is important, especially in registered herds, that each calf be marked plainly for easy identification. This is best accomplished by using metallic or composition ear tags or by tattooing the ears. Breeding and calving records, photographs, and diagrams of color markings are also helpful.

Fiber-disk ear tags used for identification are fastened to the thick upper part of the ear by means of a hog ring that pierces the ear (fig. 13).

Tattooing the ear is a simple operation (fig. 14), and insures a permanent method of identification when properly done. It is accomplished by (1) thoroughly washing the dirt and wax out of the inside of the ear with either alcohol or gasoline, and then drying the ear; (2) a series of letters and numbers composed of needle points mounted on blocks are placed in a tattoo marker, the needle points are covered with tattoo ink and they are pressed deep into the central part of the inside of the ear that is free from hair; (3) the tattoo ink or oil is then thoroughly rubbed into these perforations with the finger tips. Black tattoo ink is used for ears with light-colored skin, but is not satisfactory for ears with dark-colored skin. Red ink is sometimes used for ears with dark-colored skin, but is hard to read and not very satisfactory.

REMOVING SUPERNUMERARY TEATS

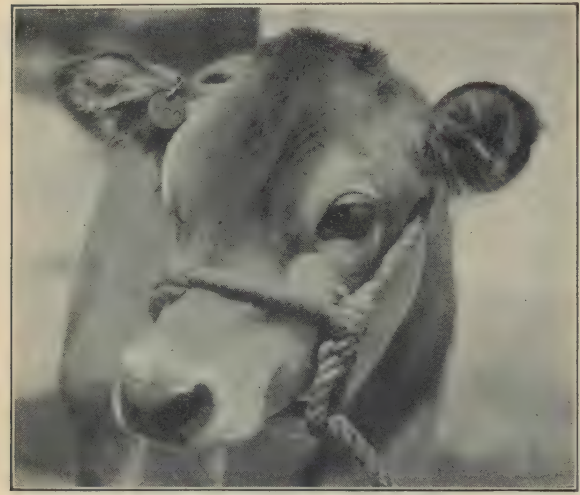

FIGURE 13.—Fiber-composition ear tag with number for identification.

Often the udder of dairy heifers has extra or supernumerary teats, in addition to the four normal teats. Although such teats do the heifer no harm, they may be unsightly when she matures and may make milking more difficult. In some cases an extra teat may secrete milk, and in that event may cause considerable bother by leaking at milking time.

Extra teats can be easily removed up to 1 year of age. Stretch out the teats and cut off close to the udder with a sharp pair of scissors. Apply iodine or some other good disinfectant both before and after the operation. In some cases in older animals it may be necessary to dissect out the teat and its accompanying gland. This should be done only by a person skilled in veterinary surgery.

PURGATIVES AND ENEMAS

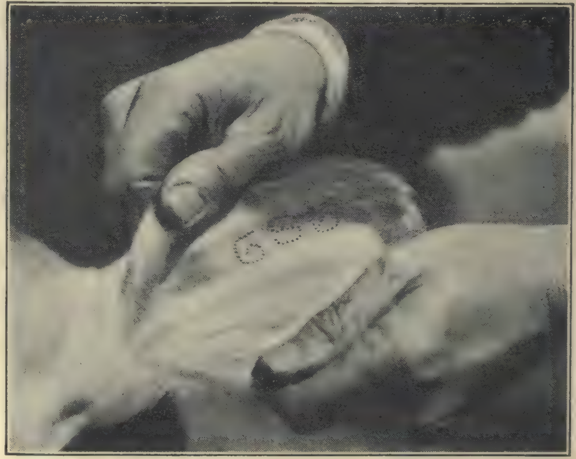

FIGURE 14.—Number tattooed in heifer's ear for identification.

Olive oil makes the best purgative for very young calves, but is more expensive than other purgatives. Mix 4 to 6 ounces of olive oil with 1 pint of warm milk. Give this to the calf from a long narrow-necked bottle either with or without a nipple. Take care to hold the bottle so that the liquid runs out slowly, or some of it may get into the lungs. Mineral oil may be used in place of olive oil.

Castor oil is a good purgative, but has a stronger action than olive oil, and may be too irritating for very young calves. The usual dose is 1 to 3 ounces, given in the same manner as olive oil.

Epsom salts makes a suitable purgative after the sixth month of age. One fourth of a pound will be enough for a 6-month-old calf, and one half pound or more may be used for older animals, depending on their size. Mix with a pint or more of warm water and give from a long narrow-necked bottle.

A physiological salt solution makes the best enema for calves. Do not use any other material as an enema except on the advice of a veterinarian. To make this solution, heat water to a temperature of 110° F. and add 1 heaping teaspoonful of common table salt to each quart of water to be used. Two quarts of this solution will be sufficient for most calves. Administer the solution by gravity through the rectum of the calf, using either a tube and funnel or an ordinary fountain syringe.

COMMON AILMENTS OF CALVES

Calves are susceptible to various ailments, some of which are unknown in older animals. They consist principally of digestive disturbances, lung troubles, and parasites. Most of these ailments can be prevented by keeping the calf in clean, well-ventilated surroundings and by proper feeding and care.

WHITE SCOURS

White scours is a specific and highly contagious disease of calves which shows itself at birth or shortly after birth. The infection usually takes place through the navel cord but may occur through the digestive system. Soiled bedding in the pen, soiled udder and teats, or sick calves in nearby pens with open partitions are possible sources of infection.

A calf affected by this disease wants to sleep all the time and cannot be induced to eat. There is a profuse discharge of yellowish-white droppings with a highly offensive odor. The disease is nearly always fatal and the calf dies within 3 or 4 days.

Preventive measures are the best cure for white scours. Have the cow calve in an isolated and thoroughly cleaned and disinfected maternity pen, care for the calf as outlined under the heading Care of the New-born Calf, and keep it isolated until all danger of the disease is past.

In case of an outbreak of contagious scours destroy the carcasses of all dead calves; remove the infected bedding and other material from the pens and destroy or spread at once on cultivated fields; thoroughly disinfect the pens and all tools and equipment used around the pens. If these measures do not prove effective, consult a veterinarian.

CONSTIPATION

When the calf is born there exists in the posterior bowel a greenish-black mass, known as "meconium." The meconium should be expelled within 12 hours. If it is not expelled, the bowel remains inactive. This condition lowers the calf's resistance to infections that may cause its death in a short time.

If the calf receives a normal quantity of the first milk or colostrum, which is purgative in nature, the meconium is usually expelled within a short time. In the few instances where the meconium is retained, its removal can be effected and the bowels started to functioning normally by a physiological salt solution used as an enema.

Constipation of older calves from other causes can be corrected by the use of a suitable purgative.

SCOURS FROM INDIGESTION

Indigestion followed by scours may be caused by overfeeding, irregular feeding, use of unclean utensils, feeding cold milk, too rapid changes in feed, cold drafts, and cold, damp floors. It is caused in most cases by overfeeding, which distends the stomach, and which in turn retards or stops the flow of gastric juices. When this happens the feed is not properly digested, the calf is weakened, resistance is lowered, and infections may gain a foothold.

The products of decomposing feed are absorbed by the body, and the calf becomes listless and dull 24 hours before any other symptoms appear. The calf may also be constipated before the scouring starts. The droppings become pasty or liquid in consistency but are not usually as light in color or as offensive in odor as in the case of white scours. In severe cases the droppings may get lighter in color, more offensive in odor, and blood may sometimes be present.

If it is noted that the calf is listless, reduce the quantity of feed and give a suitable purgative. This will check the indigestion before scouring starts, and the calf will soon be back to normal.

Where the calf has started scouring, reduce its feed by one half and give a suitable purgative. Repeat the dose in a day or two if necessary. An enema of physiological salt solution will also be helpful in clearing the infection out of the bowels.

Blood in the droppings is sometimes an indication of a disease caused by a protozoan organism. Where such a condition persists, a veterinarian should be employed to make a diagnosis and give instructions for ridding the farm of the disease.

PNEUMONIA

Congestion of the lungs, followed by pneumonia, occurs in many calves that have had indigestion and scours, especially when not properly taken care of in the early stages. The prompt treatment of scours will therefore lessen the danger of pneumonia.

Calves also get congestion of the lungs and pneumonia when exposed to sudden changes of temperature, and especially in windy weather when doors or windows are accidentally left open or are blown open. The cold draft passing over the calf takes heat from its small body, bringing on a chill.

A calf with pneumonia usually lacks an appetite, breathes rapidly, is constipated and runs a temperature as high as 105° or 106° F. Severe cases are usually fatal.

Blanket the sick calf and place it in a dry well-bedded pen at a comfortable, even temperature and away from all drafts. Give it moderate quantities of feed. Use a purgative if necessary to avoid constipation. Massage or rub the calf all over vigorously several times a day. If the animal is valuable, consult a veterinarian for further treatment.

LUNG PARASITES

In some localities, the lungs of calves become infested with parasites. When this occurs, it is best to have a veterinarian prescribe the proper treatment.

RINGWORM

Ringworm is a fungous growth characterized by circular or ringlike areas which are scabby and practically free from hair, and increase in size as the infection spreads. This ailment is most troublesome in winter when calves are closely housed. The infected areas itch, are very irritating, and give the calf an unsightly appearance. Ringworm spreads rapidly, but can be checked by thoroughly cleaning and disinfecting the calf pens, and applying salicylic ointment or a good coal-tar or iodine ointment to the infected spots. Rub the ointment in thoroughly once each day until there is a considerable improvement, and then twice each week until the infection has disappeared. Do not miss any infected spots, and be sure to cover the entire surface of each affected area. Keep the pens clean so that reinfection will not occur.

WARTS

Warts are of common occurence on calves and heifers, particularly during summer and autumn. They may occur in the skin of the head, neck, or other parts of the body. They are infectious or catching, and may spread over the body or to other animals unless steps are taken to check them. The daily application of castor oil is beneficial, and should be made when the warts are first noted and are still small. In many cases the castor oil softens the warts to the extent that they are rubbed off by the animal's movements. If this does not remove the warts, tie a silk thread tightly around the wart near the base and allow the thread to remain until the wart drops off. Animals badly infected with warts should be isolated from the rest of the herd and the exposed stables and pens disinfected. Further information on the treatment and prevention of warts is contained in U.S. Department of Agriculture Leaflet 75, Warts on Cattle.

LICE

Calves kept in clean quarters and given a thorough, vigorous brushing every day, are less likely to be infested with lice and other parasites of the skin. Lice may become quite numerous on the calf before they are detected. They are very irritating, give the calf an unthrifty appearance, and when present in considerable numbers, keep it from gaining as it should. Lice usually are not very bothersome in the spring or summer, but increase in numbers rapidly during the winter, when the calves are closely housed. In warm weather the lice can be killed by sponging or spraying the calf thoroughly with various commercial lime-sulphur, coal-tar, or nicotine dips according to the directions given on the container. Sponging or spraying usually is not advisable in cold weather, because of the danger of chilling and pneumonia. The best plan for keeping down the lice in winter is to brush the calf frequently and dust the infested parts as often as necessary with powdered borax or pyrethrum powder. In a half hour brush off any surplus pyrethrum powder so that the calves will not get any in their mouths by licking.

FLIES

Flies are particularly bothersome to young calves, especially during hot weather. The calf's skin is thin and tender, the flies are very irritating, and the calf is unable to fight them away.

Protect the new-born calf from flies by darkening the pen, and by spraying the flies on the walls and ceiling with an effective fly spray, preferably one containing kerosene and pyrethrum. Apply this in such a manner that it will be effective in killing the flies, and will not be sprayed on the calf. If the fly spray is rubbed on the calf's skin, it will cause blisters followed by severe sores.

Calf manure provides an ideal place for flies to breed. The calf pens should be thoroughly cleaned out every few days and the manure scattered so that the larvae will not develop. Throwing it in a pile will not prevent the larvae from maturing.

LEAD OR PAINT POISONING

Calves and heifers will eat paint from the walls of their pen or from any painted object or receptacle they can reach. Paint containing lead is poisonous, and if it is consumed in any appreciable quantity the animal usually dies.

This trouble can be prevented by whitewashing the walls or by using paint that does not contain any lead. Care should also be taken to keep all tools, implements, and utensils used in painting, away from cattle. Paint buckets especially should not be allowed around barns, lots, or pastures.

Billboards painted with lead paint are a source of lead poisoning, and are particularly dangerous when freshly painted. Billboards should not be erected in pastures or other places where cattle are kept unless an adequate fence is built to keep the cattle away.

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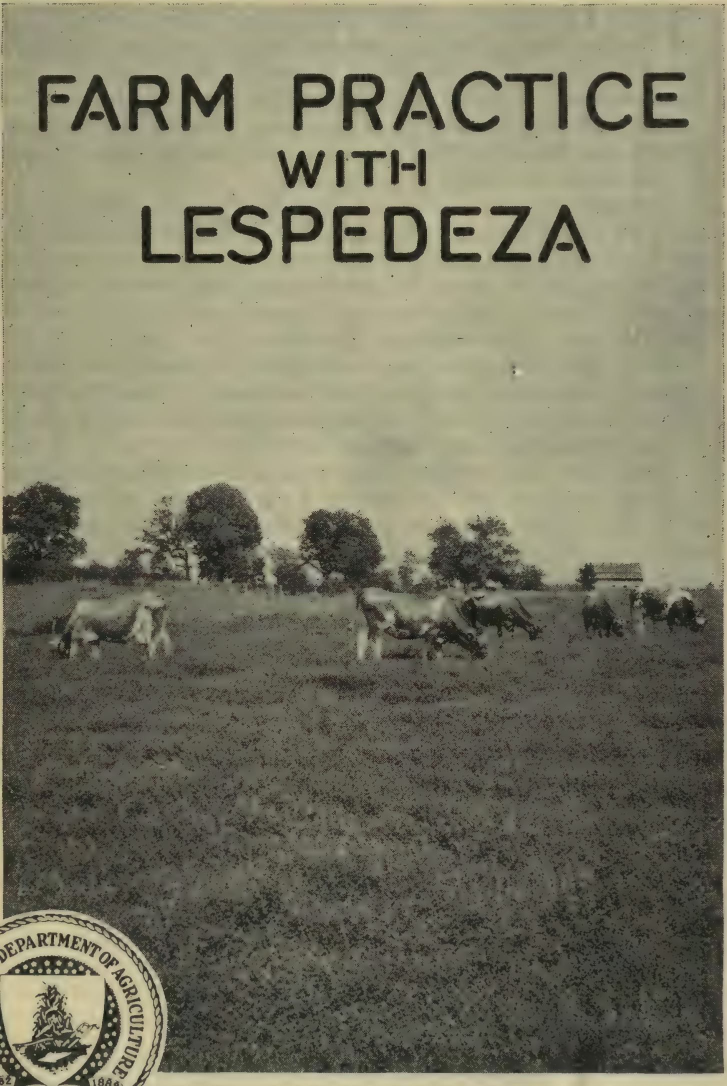
U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1724

FARM PRACTICE WITH LESPEDEZA



THE COMMON LESPEDEZA has been grown to a limited extent for hay and for pasture and soil improvement in some of the Southern States for many years. The introduction of earlier and larger growing varieties has increased the use of the crop in localities where it was already grown and has extended the lespedeza area to other States to the north and west.

Lespedeza grows readily on almost any farm soil without lime or other special soil treatment. The seed is usually sown on top of the ground much as red clover is sown. It is not necessary to cover the seed when it is sown on freshly prepared land. Fall-sown grain should be lightly harrowed either before or after the seed is sown.

Hay made from lespedeza is equal to that made from most other legumes for feeding farm animals. Lespedeza provides pasturage during the summer and fall, when many pasture grasses are more or less dormant.

Lespedeza fits readily into most of the well-established cropping systems of the area and can usually be included with little or no rearrangement of the other crops. Seeded early in the spring, it will produce a crop of hay or seed the same year, and usually the shattered seed will come up and produce a crop the following year.

On some run-down soils yields of corn, cotton, and small grains have been more than doubled after lespedeza has occupied the land for 1 to 3 years.

Washington, D.C. Issued March 1934

FARM PRACTICE WITH LESPEDEZA

By H. A. Miller, *assistant agricultural economist, Division of Farm Management and Costs, Bureau of Agricultural Economics* [1]

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INTRODUCTION

THE USE OF LESPEDEZA as a farm crop has rapidly increased during the past few years. The increase in the use of lespedeza is due partly to the excellent results that have been obtained by the farmers who have been growing the Common variety, for hay and for pasture and soil improvement, but more particularly to the introduction of some new varieties that produce better yields, are adapted to a wider range of climatic conditions, and are generally better suited to the needs of the average farm than is the Common variety.

This bulletin is based on information collected from farmers located in the States of Virginia, North Carolina, Tennessee, and Kentucky who are growing lespedeza regularly as a farm crop. The information includes methods of seeding, varieties used, the place in the cropping system usually occupied by lespedeza, and practices that have developed in connection with the production and use of the crop in these States.

LESPEDEZA AS A FARM CROP

Lespedeza came naturally into Virginia, North Carolina, Tennessee, and Kentucky and was growing in pastures and other places not disturbed by the plow long before it was grown as a field crop. In west Tennessee and the western part of Kentucky this plant was utilized to some extent for hay and pasture. The practice of sowing it on small grain did not develop in this section until about 1910. A few years later lespedeza began to be grown in some of the piedmont counties of North Carolina. Seed at that time came mostly from Mississippi and was a strain of the Common variety. Later, seed was produced locally for farm use, and the crop became well established in these two localities. The use of lespedeza as a field crop did not spread much to other parts of these States until after 1925, when seed of the new and larger growing varieties came on the market.

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[1] This investigation was conducted in cooperation with the Division of Forage Crops and Diseases, Bureau of Plant Industry. Credit is due R. E. Stitt and Howard Hyland, assistant agronomists, for assistance in obtaining the farm-practice records. Acknowledgement is also made of the information supplied by farmers, the valuable assistance of county agricultural agents in making contacts with growers, and the helpful suggestions of the officials of the experiment stations.

The production of seed for sale, which was stimulated by good prices, overshadowed for a time the use of the new varieties for hay and pasture purposes. This served to give certain of these varieties a much wider distribution than would otherwise have taken place in so short a time. It also resulted in lespedeza being grown on some of the best land as well as on land in need of improvement.

In much of the area made up of the four States of Virginia, North Carolina, Tennessee, and Kentucky red clover has been chiefly relied on for many years to keep the soil in a productive condition; where it can be successfully grown there is no better crop for this purpose. On many farms, however, it has become increasingly difficult to grow clover without lime. Even after the land has been limed, unfavorable seasons and other causes have made clover failures all too frequent. Lespedeza has not only filled the gap left vacant on these farms by the failure of the clovers, but it has provided a means of building up and maintaining the fertility of the soil over a considerable part of the area where red clover cannot be grown.

Lespedeza will grow on almost any type of soil. It does well on the sandy loam soils of the Coastal Plain, the clays of the piedmont, and the limestone soils of Virginia, Tennessee, and Kentucky. Like most other farm crops, lespedeza does better on good land and makes its best growth on fertile, moist bottomland, where yields of 2 to 3 tons of hay per acre are not uncommon.

VARIETIES

The four varieties of lespedeza most generally grown at present are the Common, Tennessee 76, Kobe, and Korean. All of these are annuals; that is, they grow from seed each year. They make their best growth during the summer months; grow more upright in thick stands; and although drought resistant, they make larger yields of hay on fertile moist bottomlands than they do on the drier uplands.

When seed of the improved varieties became available, it was natural that the farmers who were already growing the Common and who were familiar with the details of production should be among the first to grow them. In many cases two or more varieties were grown on the same farm and in some cases in the same field, providing an excellent opportunity for a comparison of varieties. The Kobe and the Korean also began to be grown in other parts of these States where lespedeza had not been grown before.

The Common variety is an excellent pasture plant, coming as it does into native pastures and waste places. It reseeds even when closely grazed and, although more persistent, it does not provide as much grazing as some of the earlier, larger growing, varieties. The plants of the Common variety have a spreading habit, grow close to the ground, and, except in thick stands on fertile, moist land, this variety does not make very large yields of hay. Under similar conditions the Kobe and Tennessee 76 will yield from 30 to 50 percent more hay. This in a large measure accounts for the fact that these two varieties are replacing the Common as a hay and pasture crop on many farms in North Carolina and Tennessee.

The Tennessee 76 is a selection from the Common made by the Tennessee Agricultural Experiment Station. Although this variety retains some of the characteristics of the parent stock, it grows more upright and produces larger yields of hay than the Common. It is largely because of the more upright growth and larger yields of hay that Tennessee 76 has replaced Common on many farms in North Carolina and Tennessee.

Both of these varieties are late and do not provide much pasturage before July but continue to grow until killed by frost in the fall. Common matures seed 2 to 3 weeks earlier than Tennessee 76. The seed yield of the latter is sometimes cut short by early frosts. These two varieties are grown more generally in west Tennessee and the southern half of the piedmont section of North Carolina than in other parts of the area. Common is also grown in that part of Kentucky west of the Tennessee River and occurs as a naturalized plant in other parts of Kentucky and Virginia, where it comes naturally into pastures and waste places.

The Kobe variety usually provides somewhat earlier grazing than Common, matures seed in October, and like Common and Tennessee 76 continues to grow until killed by frost in the fall. Kobe not only does well in the same localities of North Carolina and Tennessee where Common and Tennessee 76 are grown, but is also producing good yields of hay and seed in other parts of these States and in western Kentucky and the eastern part of Virginia. As only a small proportion of the seed matures before the middle of October, Kobe may not produce much seed in the higher altitudes of these States or where killing frosts occur before the latter part of October.

Seeded at the same rate as the other varieties, Kobe usually produces a thinner stand. This was regarded by some growers as a weakness of the variety. Since Kobe seed is somewhat larger than seed of the other varieties, there are fewer seed per pound, so to obtain the same stand more pounds per acre must be sown. For that reason most growers sow from 10 to 15 pounds more per acre of Kobe seed than they do of the other varieties. The experience of many farmers who have grown the four varieties is that Kobe will make more growth on thin land, will produce larger yields of hay, and is less affected by "scald" than the others.

The Korean differs from the other varieties in several important respects. The seed germinates at a lower temperature, and the young plants make more growth early in the season than do those of the other varieties. As a result Korean will provide grazing for livestock from 2 to 3 weeks earlier than Common. As Korean starts earlier in the spring and matures seed 3 to 4 weeks earlier than the other varieties, it is adapted to a much wider range of climatic conditions. It not only does well in North Carolina and Tennessee but is now grown much farther north and readily produces an abundance of seed where killing frosts do not occur before the middle of September. Because of its early maturity Korean is not so well suited as some of the other varieties to the Gulf States, except the extreme northern parts.

METHODS OF SEEDING

Farmers who grow wheat, rye, oats, and barley usually sow lespedeza on top of one of these grains early in the spring. The seed is usually sown broadcast either by hand or with a hand broadcast seeder and is not covered, although most growers agree that the seed should be lightly covered. Lespedeza seed sown on a hard, smooth soil may drift into piles causing an uneven stand, and in some cases it may actually be washed away during a hard rain. For this reason many growers prefer to go over the fall-sown grain with a section harrow, set so the teeth slope back just enough to slightly loosen the soil after the seed has been sown. Others sow the seed behind the harrow. Either method gives good results. The action of the harrow does not injure the grain.

Another method used by some growers is to sow the seed with a disk grain drill. The drill is set so the disks cut a shallow groove in the soil. This prevents the seed from drifting and provides sufficient loose soil to cover the seed. Land on which spring oats has been sown provides a good seed bed for lespedeza. In this case the seed is nearly always sown broadcast behind the drill. Farmers that do not grow the small grains sow lespedeza on land that was in soybeans or an intertilled crop the year before. Cotton and corn ground is prepared for lespedeza by disking and harrowing to level the surface, after which the seed is sown broadcast and left on top of the ground to be covered by the first rain. Lespedeza sown on ground prepared in this way, if covered at all, should be covered very lightly.

Lespedeza is frequently sown under conditions that make it rather difficult to obtain the ideal seed bed. This is the case when it is sown on meadows, pastures, and eroded hillsides. In such cases the seed is sown broadcast on top of the ground, and nature does the rest. The results in most instances are surprisingly good. A more dependable method, and one followed by some farmers in seeding lespedeza on old pastures, is to go over the pasture with a spring-tooth harrow set lightly or a disk set at a slight angle in order to loosen some soil before the seed is sown.

TIME AND RATE OF SEEDING

In North Carolina and Tennessee, lespedeza is usually sown during February and March, and in Kentucky and Virginia, during March and the first half of April. The time of seeding, within rather wide limits, is less important than the condition of the land at the time of seeding. It can be sown much later in the spring on freshly prepared land. The seed can be readily covered by mechanical means or left to be covered by the action of rain. When the seed is to be sown on top of winter grain, old pastures, or land lying out, most growers prefer to sow early while the land is still soft and porous, so the seed can work down into the soil before it germinates, rather than wait until the land has become hard and dry. There is some risk in very early seeding, especially in the case of Korean and Kobe varieties.

Seed sown early may germinate during a period of mild weather, and later the young plants may be killed by freezing temperatures. Many February seedings were killed by the severe freeze the first week of March in 1932, making it necessary to reseed the fields. Volunteer stands were also killed, but in most cases seed left in the soil came up later and produced good volunteer crops that year. This was an unusual season.

The rate of seeding depends to a certain extent at least on the purpose for which the crop is to be grown and whether a full stand is to be obtained the first year. If a full stand is expected the first year the usual rate of seeding is from 25 to 30 pounds per acre. Many growers prefer to sow from 35 to 40 pounds per acre. The heavier seeding gives better weed control and usually produces larger yields of hay. It should be remembered that all of the annual varieties grow taller and more upright in thick stands. If a full stand is not expected the first year, 10 to 15 pounds per acre will make a fair crop the first year and will reseed the land for a full crop the following year.

The rate of seeding when the crop is intended for pasture is usually from 20 to 25 pounds per acre for lespedeza alone and from 15 to 20 pounds per acre when sown on old pastures that are in need of improvement. The quantity of lespedeza seed included in pasture mixtures varies from 6 to 10 pounds per acre.

HAY

Most growers consider hay made from lespedeza equal in value to hay made from most other legumes for feeding farm animals. Lespedeza hay is readily eaten by all classes of livestock, and there is little or no waste in feeding it. It can be cut at almost any stage of maturity, from the time there is sufficient growth to justify cutting until after the seed begins to ripen, without greatly affecting the quality of the hay, except where the growth is very large. In thick stands where the plants grow large the leaves near the ground may drop off. This is locally known as "scald." It reduces the proportion of leaves to stem, and since the stems are larger than where the growth of plants is moderately large there is some waste in feeding.

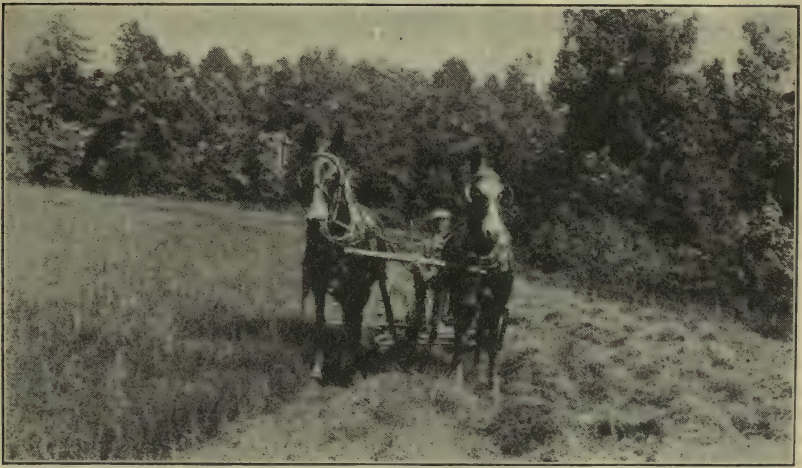

FIGURE 1.—A good stand of lespedeza on fairly productive upland soil.

Lespedeza hay is usually more easily cured than is a similar tonnage of other legumes. A light crop can be cut and hauled in the same day. The usual practice with a heavy crop is to cut it after the dew is off and rake it into windrows before the hay is completely dry in order to prevent the leaves from shattering. The hay is then allowed to cure in the windrow or small cock for a day or two, depending on the yield and weather conditions.

The yield of hay depends on several factors, the more important of which are soil fertility and moisture. On thin upland soils not more than 1 ton per acre can be expected. On moist, fertile bottomland yields of 2 to 3 tons per acre are not unusual (fig. 1).

Mainly because of the thicker stand, second-year volunteer crops usually produce larger yields of hay than do first-year seedings. Third-year volunteer crops are more likely to be weedy and therefore not so desirable for hay.

When a volunteer crop is expected, following a crop of hay, the hay must be cut early and high enough so the second growth will have time to produce seed, or the cutting must be delayed until part of the seed has matured sufficiently to be shattered out while the hay is being cut.

By taking advantage of the fact that some grasses are ready to cut for hay in May and June, a crop of grass hay and a crop of lespedeza hay can be obtained the same year. An example follows: A mixture of red top and orchard grass was sown with winter oats in the fall. The following spring 30 pounds per acre of Kobe lespedeza was sown on top of the oats and grass in March. The oat crop was harvested for grain and the Kobe lespedeza for seed. The next year 2 tons per acre of grass hay was harvested in June and 1½ tons per acre of lespedeza hay in October. The following year the grass made a yield of 1½ tons and the lespedeza of 2 tons of hay per acre.

PASTURE

Lespedeza sown on small grain early in the spring is usually ready for grazing soon after the grain is removed from the field. Sown alone, the Korean variety will usually be ready early in June, Kobe about 2 weeks later, and Common and Tennessee 76 about the first of July. The pasture season for Korean extends into September, when the seed matures and the plants turn brown. The other varieties are later and usually stay green until frost. The lespedezas make their best growth during the hot summer months and provide excellent grazing during the season when many grasses are more or less dormant. During the severe drought of 1930, when many new seedings of grass and clover were lost on account of dry weather, the lespedezas not only survived the very unfavorable season but actually provided grazing for livestock at a time when most other pasture plants failed.

Since lespedeza does not provide much grazing before June or July, early spring pasture must be provided by the grasses or a small grain grown for that purpose. The practice of sowing lespedeza on native pastures, rotation pastures, and permanent pastures, has become rather general not only on livestock farms but also on crop farms that maintain pastures for work stock and other farm animals. The grasses usually make their best growth early in the season and provide the early grazing, whereas the lespedeza occupying the thin places and bare spots comes on later to provide grazing during the summer and fall. The carrying capacity of old pastures has been more than doubled in many cases by sowing 10 to 15 pounds per acre of lespedeza seed on them early in the spring.

On some farms fall-sown small grain with lespedeza, seeded early in the spring, takes the place of the pasture grasses for early grazing. Rye or winter barley sown early in the fall provides the early spring grazing and by the time the grain is eaten down the lespedeza is usually large enough to carry the animals through the season. Such pastures can be renewed by disking the land in the fall after the lespedeza seed has matured and again drilling in rye or barley, allowing the lespedeza to volunteer. Should the land be too hard to be put in order with a disk, a subsoiler may be used to break it up after which the land is disked and seeded. The Kobe or the Korean varieties are more frequently used for this method of providing pasture.

The carrying capacity of lespedeza pastures varies with the season, fertility of the soil, and method of grazing. The improved varieties, more particularly Kobe and Korean, were grown principally for seed until the price of seed dropped in the spring of 1932, when they were used more generally for hay and pasturage, especially on farms where livestock is an important enterprise. Few Kobe or Korean pastures have been grazed to their full capacity. Table 1 shows the time 10 fields of lespedeza were grazed and the number of animal units [2] pastured per acre. The lespedeza on most of these fields was grazed after the removal of a crop of small grain and in some instances the animals were taken off early so that a crop of seed could be harvested. The time grazed does not in all cases, therefore, represent the total time the field could have been grazed.

TABLE 1.—*Lespedeza pasture: Time grazed and number of animal units pastured on lespedeza alone*

State	Acres pastured	Time grazed	Days pastured	Total animal units	Animal units per acre	Variety
North Carolina	16	June 1–Oct. 15	137	10	0.62	Common.
	16	do	137	16	1.0	Do.
	18	June 15–Sept. 1	77	18	1.0	Korean.
	2	June 10–Sept. 20	102	4	2.0	Do.
	22	July 20–Aug. 31	42	60	2.7	Do.
	7	July 1–Sept. 30	92	14	2.0	Do.
Kentucky	100	July 1–Oct. 20	112	75	.75	Kobe and Korean.
	20	June 15–Oct. 20	127	16	.8	Kobe.
	25	July 1–Oct. 15	107	25	1.0	Do.
	25	do	107	40	1.6	Kobe and Korean.
Total	251		1,040	278		
Average	25.1		104		1.1	

Table 2 shows the time grazed and the number of animal units pastured per acre when lespedeza was included in pasture-grass mixtures, seeded on old pastures, and, in the case of one field, seeded on rye. The average number of animal units pastured per acre is the same as for lespedeza alone, but the average number of days pastured is about double that for lespedeza alone, or 211 as compared with 104.

TABLE 2.—*Lespedeza pasture: Time grazed and number of animal units pastured on lespedeza and grass*

State	Acres pastured	Time grazed	Days pastured	Total animal units	Animal units per acre	Variety used
North Carolina	14	Apr. 1–Feb. 1	275	20	1.4	Korean in mixture.
	14	Feb. 1–Oct. 30	273	10	.7	Do.
	35	Apr. 1–Oct. 30	213	39	1.1	Korean and bluegrass.
Kentucky	55	Apr. 1–Sept. 10	162	80	1.4	Korean on old pasture.
	35	Apr. 15–Sept. 10	147	35	1.0	Do.
	40	May 15–Nov. 15	184	45	1.1	Korean, Kobe, and grass.
	20	Mar. 10–Oct. 20	224	20	1.0	Kobe seeded on rye.
Total	213		1,478	249		
Average	30		211		1.1	

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[2] An animal unit is 1 horse, mule, or cow; 2 yearlings; or 4 calves or colts; or 5 hogs; or 10 pigs; or 7 sheep or goats; or 14 lambs or kids.

A few results from grazing lespedeza follow.

Twenty acres of rye seeded to Kobe lespedeza in March 1931 was harvested for grain, and the lespedeza was harvested for seed. The rye and the lespedeza volunteered, and the field was grazed by 80 head of hogs from March 15 to the end of the season. In addition, 20 calves were grazed on the field. The first week in August it was mowed and 20 tons of hay was obtained. By the first of October the lespedeza had grown up, and another ton of hay per acre could easily have been cut.

On another farm, 50 acres of Kobe and 50 acres of Korean lespedeza furnished grazing for 75 head of cattle from July 1 to frost. A permanent pasture provided the early grazing.

On still another farm 25 acres of timothy and redtop on which 10 pounds per acre of Korean seed was sown in March, provided early pasture for 60 cattle and 100 sheep. This 25 acres and 30 acres of second-year Korean lespedeza were grazed alternately, and carried the 60 cattle and the 100 ewes and their lambs from April 1 to September 10. The 30 acres of Korean also produced a crop of seed.

SOIL IMPROVEMENT

The soil-building qualities of lespedeza are well known to most growers, yet the crop is seldom grown exclusively for that purpose. Soil improvement, in most cases, has come about in connection with the production of the crop for other purposes. In spite of the fact that the crop is nearly always removed from the land as hay, pasturage or seed, the yield of crops that follow 1 or 2 years of lespedeza are nearly always better than those that do not.

Lespedeza, like most other legumes, adds nitrogen to the soil through the action of the nitrogen-fixing bacteria that develop on the roots of the plant. Lespedeza has some advantages over most other legumes for soil improvement in that it will grow on almost any soil without artificial inoculation, fertilizers, or lime. It reseeds and makes a better growth the next year and rarely fails through unfavorable seasons. The expense of getting it started is little more than the cost of the seed.

The average yield of corn for all farms from which yields were reported was 15.4 bushels per acre where lespedeza had not been grown and 44.5 bushels per acre where corn followed lespedeza. The average yield of cotton was 200 pounds, or less than one half bale, per acre where cotton did not follow lespedeza and 1.1 bales per acre when cotton followed 1 or 2 years of lespedeza.

Table 3 shows the yield of corn on six fields before lespedeza was grown and the yield of corn on each field after the land had been in lespedeza from 1 to 3 years.

TABLE 3.—*Effect of lespedeza on the yield of corn*

State	Area in corn	Yield of corn before and after lespedeza was grown—			Increase in yield	
		Before	Period in lespedeza	After	Bushels	Percent
	Acres	*Bushels*	*Years*	*Bushels*		
North Carolina	20	10	1	25	15	150
	21	20	2	40	20	100
Kentucky	35	25	2	40	15	60
Tennessee	30	20	2	40	20	100
North Carolina	6	16	3	62	46	287
Tennessee	24	25	3	40	15	60
Total	136	116		247	131	
Average	22.6	19.3		41.1	21.8	113

The increase in the yield of corn is greater, of course, on the fields where the yield was lowest before lespedeza was grown (fig. 2). The effect of a soil-building crop on yields usually varies with the kind of soil. The heavier soils respond more readily to a small increase in the organic content than do the lighter soils. Since the soils on which these fields are located vary from a rather light sandy loam to a heavy clay loam there is little relation between the yield and the number of years the field was in lespedeza.

The crop yields shown in tables 3 and 4 were made on different farms in two widely separated areas of North Carolina and Tennessee during the period from 1923 to 1931, inclusive. There was no increase in the quantity of fertilizer applied to the corn and cotton that followed lespedeza. On 3 of the 6 fields mentioned in table 3 no fertilizer was applied to either corn crop. Table 4 shows the yield of cotton on 10 fields before lespedeza was grown and the yield of cotton on the same fields after the land had been in lespedeza from 1 to 4 years. There was no increase in the total quantity of fertilizer applied to the cotton that followed lespedeza but in several cases there was an actual decrease in the quantity of nitrogen applied when cotton followed 3 years of lespedeza.

TABLE 4.—*Effect of lespedeza on the yield of cotton*

State	Area in cotton	Yield of lint cotton before and after lespedeza was grown—			Increase in yield	
		Before	Period in lespedeza	After	Pounds	Percent
	Acres	*Pounds*	*Years*	*Pounds*		
North Carolina	15	250	1	500	250	100
	12	250	2	500	250	100
Tennessee	15	100	2	250	150	150
	23	375	2	500	125	33
North Carolina	16	125	3	500	375	300
Tennessee	12	167	3	500	333	199
	30	250	3	500	250	100
	29	250	3	600	350	140
	17	334	3	750	416	124
North Carolina	24	125	4	800	675	540
Total	193	2,226		5,400	3,174	
Average	19.3	222.6		540	317.4	142

The difference in yield may be partly due to seasonal variation, but the fact that the yields occurred in different years on a number of farms in different localities indicates that the increase in yield is in large part due to the effect of lespedeza.

The increase in the yield of cotton closely follows that of corn in that the greater increase usually occurs on the fields where the yield was lowest before lespedeza was grown. The increase in the yield of cotton is somewhat greater following 3 years of lespedeza than following 2 years.

The low initial yields on these fields were not due so much to improper methods of farming as to the failure of the crops that are generally relied on to keep the soil in a productive condition. This is well illustrated by the results on a grain-and-livestock farm where lespedeza has taken the place of clover in the rotation. The land on this farm is rolling, with an upland clay soil that is fairly productive when well supplied with organic matter.

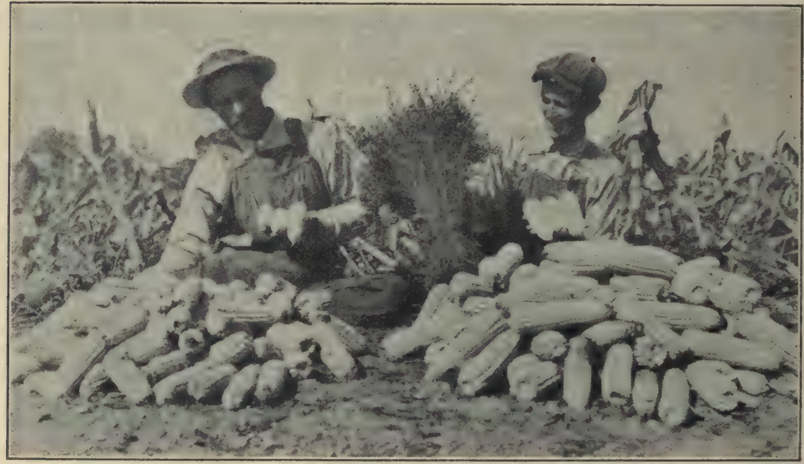

FIGURE 2.—Corn grown after lespedeza produced 46 bushels per acre (right), as compared with 25 bushels per acre (left) when corn was grown in the same field on land on which no lespedeza had been grown—an increase of 21 bushels per acre, or 84 percent, due to the previous growing of lespedeza.

The crop rotation was corn, wheat, and hay. Redtop, orchard grass, and red clover were sown for hay. Oats came into the rotation occasionally as a grain crop. Fertilizers were used regularly, and occasionally the land was limed. The crop yields with this system were: corn, 13 bushels; wheat, 8 bushels; oats, 20 bushels; and hay, 1 to 1½ tons per acre.

The essential difference between the system just outlined and the one now in use is that lespedeza takes the place of the clover and grasses in the rotation and lime is not used at all. The rotation now is corn, wheat seeded to lespedeza, and oats seeded to lespedeza. Lespedeza is seeded on the wheat in February and on the oats behind the drill in February or March. The rate of seeding lespedeza is 25 to 30 pounds per acre. After the grains are harvested, the lespedeza occupies the land the remainder of the season and is used for hay, pasturage, or seed. Although this system has been in operation only a few years, the crop yields have increased and in 1932 were 50 bushels of corn, 24 bushels of wheat, 40 bushels of oats, and 1½ to 2 tons of hay per acre, respectively.

The following is an example of the way lespedeza was used to bring back some very unproductive land: The soil on this farm, a sandy loam, was badly eroded and was reduced in fertility to the point where 10 acres of cotton with 200 pounds per acre of 2–8–2 fertilizer produced a total yield of only 2 bales, or 100 pounds of lint cotton per acre. The county agent for some time had encouraged the use of lespedeza as a farm crop in the county, and at his suggestion a rotation of cotton 1 year and lespedeza 2 years was begun. The cotton ground was disked and harrowed in the spring and seeded to lespedeza at the rate of 25 pounds per acre without fertilizer. The lespedeza was cut for hay in places where it grew tall enough, and the land was turned for cotton. The improvement was slow and took several years. In 1931 the same field, with an application of 95 pounds of 16-percent superphosphate per acre, made a yield of 1⅓ bales, or about 660 pounds of lint cotton per acre.

In another case oats on the same field 3 years in succession gave the following results: A field of run-down cotton land was plowed and seeded to oats in February with 10 pounds per acre of Korean lespedeza seeded on top of the ground behind the drill. The land was then fertilized with 500 pounds of basic slag and 200 pounds of 4–8–8 fertilizer per acre. The yields the first year were 26 bushels of oats and 9 bushels of lespedeza seed per acre. After the lespedeza seed was harvested the land was turned and left until the next spring, when it was disked to bring the shattered lespedeza seed to the surface and was again seeded to oats. No lespedeza seed was sown after the first year. The yields the second year, with 200 pounds of 4–10–4 fertilizer per acre, were 43 bushels of oats and 14 bushels of lespedeza seed per acre. The same procedure was followed for the third crop of oats. The yields the third year, with 200 pounds of 4–10–4 fertilizer per acre, were 74 bushels of oats and 20 bushels of lespedeza seed per acre.

FERTILIZERS

Lespedeza responds readily to the application of fertilizers and from a soil-building viewpoint fertilizers should be more generally used when lespedeza is sown on land that is low in fertility. The fertilizer most generally applied to lespedeza is similar in analysis to that applied to the other crops, except that on the more fertile soils the nitrogen may be omitted. On some soils phosphate alone is applied, on others phosphate and potash are both used. Some of the lespedeza-seed growers are using a complete fertilizer, analyzing 4 percent of nitrogen, 12 percent of phosphoric acid, and 4 percent of potash, at the rate of 400 to 500 pounds per acre when lespedeza is sown for the first time on thin land. On land that is in a more productive condition 200 to 300 pounds of a 0–10–4 mixture is used. A few growers are using basic slag at the rate of 400 to 500 pounds per acre.

Lespedeza seeded on grain that has been fertilized derives some benefit from the fertilizer that may be left in the soil, but usually the quantity of fertilizer applied is little in excess of the quantity needed by the grain and does not greatly benefit the lespedeza, especially when the lespedeza stays down 2 or 3 years following the grain. The yields of lespedeza have usually been better where grain and lespedeza are grown on the same land 2 or more years in succession, since each grain crop is fertilized and more fertilizer is left in the soil for the lespedeza.

The value of a soil-building crop depends on the quantity of nitrogen and organic matter it will add to the soil. Since the quantity of these materials produced depends to a large extent on the growth made, the soil can usually be built up more rapidly by applying fertilizer to the legume grown for this purpose. Two or three hundred pounds per acre of superphosphate applied to lespedeza that is to be turned under for corn will usually produce a better yield of corn than the same quantity applied to the corn crop directly.

LIME

Lime is usually applied either to correct soil acidity or to improve the physical condition of the soil. Frequently it does both and may also supply the calcium necessary for plant growth.

Lespedeza does not appear to be sensitive to most soil conditions that are usually corrected by the application of lime. But like many other crops it does better on land that is in good physical condition, and when an application of lime improves the physical condition of the soil it will have a beneficial effect on the growth of lespedeza just as it does on other crops that do not require a neutral or alkaline soil.

Comparatively few growers lime the land for lespedeza. In most cases lime does not appear to be necessary. Lespedeza is frequently grown, however, on land previously limed for other crops and nearly always does well. On one farm the Korean and the Kobe varieties were seeded on fall-sown barley and rye, respectively, after the land had been prepared and limed at the rate of 2½ tons per acre. This was a rather heavy clay soil. Both varieties made an excellent growth. The greater part of the acreage of lespedeza in Virginia, North Carolina, and Tennessee occurs on land that has not been limed, and on much of this land alfalfa and clover cannot be grown at all without heavy applications of lime.

SOIL EROSION

Soil erosion is a serious problem on many of the farms located in the area under discussion, and every effort should be made to prevent the loss of fertility from soil washing. The extent of washing varies with the kind of soil, slope of land, and methods of farming. Erosion is more severe, other factors being equal, where a large part of the farm is in intertilled crops from year to year than where the grasses and other soil-holding crops are included in the cropping system. Farmers located on land that is inclined to wash, all report much less washing on fields where lespedeza is grown. They state that lespedeza not only reduces the amount of soil washing while the crop occupies the land, but the mass of fibrous roots continues to hold the soil for 1 or 2 years after the crop is removed, permitting the land to be farmed in intertilled crops and reducing the loss in fertility from excessive soil washing.

It would be difficult to estimate the value of the Common lespedeza, growing as it does in pastures, open woodland, and waste places, as a soil-holding plant. The improved varieties have also proved very effective as soil-holding plants. In a number of instances, Korean seeded on badly eroded hillside pastures has completely stopped soil washing in 2 to 3 years. Lespedeza might well be used to stop the erosion of highway embankments and to help in other instances where the soil needs to be held in place.

ORCHARD COVER

The Common lespedeza has been used for some time as an orchard cover by Tennessee fruit growers. The introduction of the improved varieties has extended this practice to other localities. In Maryland and Virginia the Korean variety is used by some of the fruit growers as a cover crop in peach and apple orchards. The usual practice is to disk and harrow the land early in the spring while the soil is still loose and easily worked and to sow the seed in March or the first part of April. Lespedeza will grow in partial shade, adds nitrogen and organic matter to the soil, and holds the land in place. Once established in an orchard, it will reseed each year and yield a cutting of hay (fig. 3).

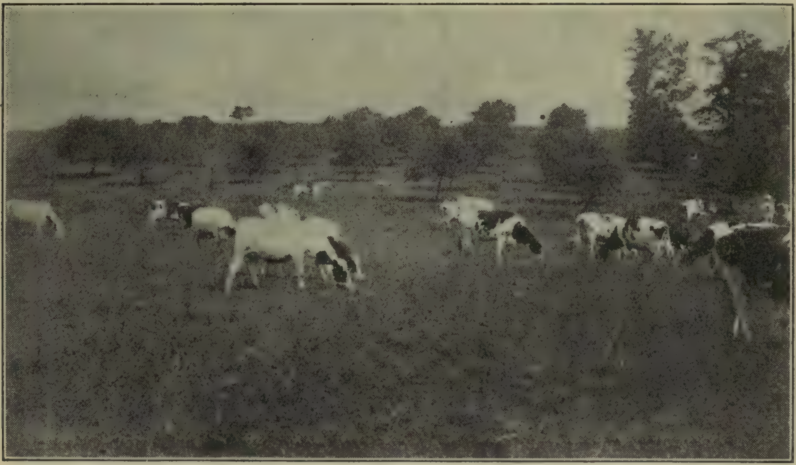

FIGURE 3.—Lespedeza used for orchard cover and for pasture.

The orchard can be disked and harrowed in the usual way without interfering with the lespedeza, provided the disking is done early, before much of the seed has germinated. If the land were plowed, the seed would be turned under too deep for the crop to volunteer, and a new seeding would be necessary for a full stand.

CROPPING SYSTEM

A great many of the cropping systems in use in Virginia, North Carolina, Tennessee, and Kentucky include one or more of the small grains. In cropping systems that include a small grain, lespedeza nearly always follows the small grain and precedes an intertilled crop. In cropping systems that do not include a small grain, lespedeza follows an intertilled crop and occupies the land 1 or 2 years, during which time it is cut for hay or seed.

The fact that lespedeza can be grown on almost any part of the farm without the necessity of liming the land or giving it other special treatment makes the crop readily available for use in cropping systems in which a legume is needed for hay, or for pasturage or soil improvement. The Korean variety matures seed in time to permit a fall-sown crop to be planted the same year. A fall-sown crop can also follow the other varieties when they are cut for hay.

A field can be seeded to lespedeza in the spring, and a crop of hay or seed can be harvested the same year. The land can then be turned for the next crop, or the lespedeza can be allowed to volunteer for hay or seed the second year. The place that lespedeza occupies in the cropping system and the use made of the crop vary with the type of farming. The cotton grower located on a sandy loam soil usually employs a slightly different cropping system from that employed by the cotton grower on a clay soil, and both systems may be different from those in use on grain and livestock farms.

Few, if any, changes in the crop sequence need be made when lespedeza is added to the cropping system. In many rotations lespedeza either takes the place of the grass and clover or is grown with them. Where the soil and climatic conditions are unfavorable for the production of clover and grass, lespedeza can be grown to supply the nitrogen and organic matter necessary to maintain soil fertility and round out the rotation. In a few cases a small grain—usually oats—has been added to the cropping system, since a crop of oats and a crop of lespedeza can be grown on the land the same year without an extra plowing.

The rotations outlined below are all in actual use and are given here to show how lespedeza fits in with some of the other crops usually grown in the area under discussion.

The following 3-year rotation is used on farms on which cotton is an important crop and on which wheat does not yield well:

First year, cotton or corn.
Second year, oats, seeded to lespedeza.
Third year, volunteer lespedeza.

The acreage of oats in this rotation is the same as the combined acreage of cotton and corn, since oats follows both of these crops.

The second year of this rotation provides a crop of oats for hay or grain and a crop of lespedeza hay or seed. The lespedeza can be left to volunteer for the third year of the rotation or the land can be turned for the next crop. The usual practice is to let the lespedeza volunteer 1 or 2 years. On farms on which cotton is grown only on certain fields of the farm because of the difference in soil conditions, two rotations are used—one for cotton and another for corn.

Where the soil is sufficiently uniform and adapted to the production of wheat and oats as well as cotton and corn, one of the following 3-year rotations is used:

First year, cotton or corn.
Second year, wheat, seeded to lespedeza.
Third year, oats, seeded to lespedeza.
First year, corn, with soybeans between the rows.
Second year, cotton.
Third year, wheat or oats, seeded to lespedeza.

Each of these rotations can be lengthened by allowing the lespedeza to volunteer.

Another 3-year rotation used mainly on sandy loam soils adapted to the production of peanuts as well as cotton follows:

First year, peanuts.
Second year, small grain, seeded to lespedeza.
Third year, cotton.

Small grain—winter oats or rye—is seeded by hand on the peanut field just before the peanuts are dug. After the peanuts are stacked the land is harrowed to level the surface and cover any of the grain not covered by the digging operation. Corn is grown on another part of this farm not so well adapted to the production of cotton and peanuts.

The following 4-year rotation is in use on a farm on which dairying is an important enterprise:

First year, cotton.
Second year, winter oats and vetch, seeded to lespedeza.
Third year, corn, with soybeans between the rows.
Fourth year, wheat, seeded to lespedeza.

This rotation provides hay and grain for the dairy cows and two cash crops. A legume is grown on 3 of the 4 fields each year.

In Kentucky and Tennessee dark tobacco is usually grown on soils that are fairly well-adapted to the production of wheat as well as tobacco, and, in the rotation most generally employed, corn or tobacco is followed by wheat, on which grass and clover for hay are seeded the third year of the rotation.

First year, corn or tobacco.
Second year, wheat and timothy, seeded to clover, and lespedeza.
Third year, hay—timothy and clover and lespedeza.

The clover and lespedeza produces a crop of hay after the wheat is harvested, and the following year a crop of timothy and clover can be cut early in the season and later the same year a crop of lespedeza hay or seed can be harvested.

Tobacco growers who do not lime the land regularly and have difficulty in getting red clover to grow, either sow lespedeza alone or a mixture of redtop and lespedeza in place of timothy and clover. Most growers report an increase in yield and a better quality of tobacco when tobacco follows lespedeza.

The following 4-year rotation of corn, wheat, oats, and hay, in use on many farms where livestock is an important enterprise, has been considerably improved by the addition of lespedeza.

First year, corn, with soybeans between the rows.
Second year, wheat.
Third year, oats, seeded to grass and clover.
Fourth year, hay, grass and clover.

It will be observed that grass and clover does not follow the wheat since the wheat stubble must be turned for the oats and this does not allow sufficient time for the grass and clover to become established before the field is plowed for oats. The grass and clover following the oats may produce a light crop of hay if the season is favorable. The same rotation with lespedeza added is as follows:

First year, corn, with soybeans between the rows.
Second year, wheat seeded to lespedeza.
Third year, oats, seeded to grass and lespedeza.
Fourth year, hay or pasture.

With lespedeza added to the rotation, a legume is on the land each year. The lespedeza seeded on the wheat produces a crop of hay or seed, and the grass and lespedeza seeded on the oats produces a crop of lespedeza hay. The fourth year of the rotation a crop of grass hay and a crop of lespedeza hay or pasture are produced. The grass will provide early grazing and carry the animals until the lespedeza has made sufficient growth to carry the animals the remainder of the season.

Where the soil is well adapted to the production of wheat the 5-year rotation of corn, wheat 2 years, hay, and pasture has long been in use on grain and livestock farms. The following plan shows this rotation with lespedeza in place of the grass and clover:

First year, corn.
Second year, wheat, seeded to lespedeza.
Third year, wheat, volunteer lespedeza.
Fourth year, lespedeza.

The corn ground is disked and harrowed in the fall before the wheat is sown. Lespedeza is sown broadcast on the wheat in March. After the wheat is harvested the lespedeza produces a crop of hay or seed, after which the stubble is disked and again seeded to wheat. The lespedeza, Korean variety, reseeds the land, and a volunteer crop follows the second-year wheat. The fourth year of the rotation also provides for volunteer lespedeza, which is used for hay, pasture, or seed. A crop of corn, 2 crops of wheat, and 3 crops of lespedeza are produced with 1 plowing.

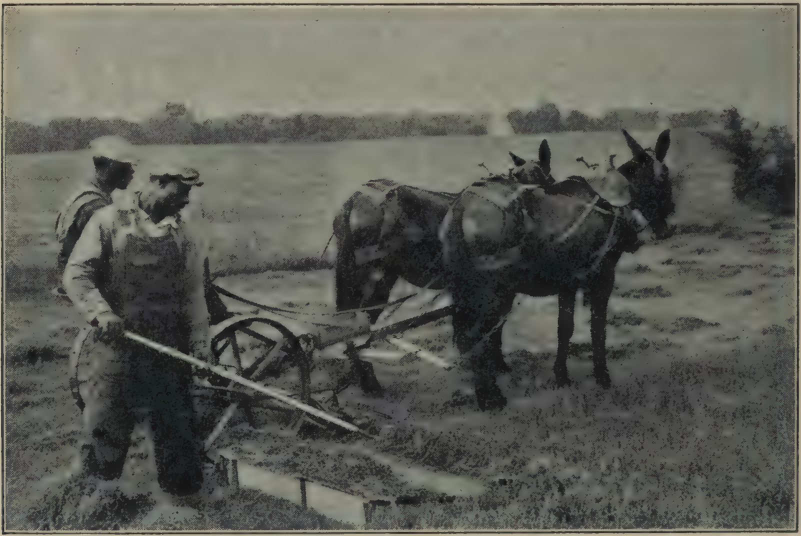

FIGURE 4.—Harvesting seed of the Common and Tennessee 76 varieties by means of a seed pan attached to the back of the cutter bar of a mower.

SEED

Seed of the Common and Tennessee 76 varieties is nearly always harvested by attaching a seed pan to the back of the cutter bar of a mower (fig. 4). The Kobe can also be harvested this way, but because the seed of the Korean is held more firmly and does not shatter so readily as the other varieties, the pan method is not used to any extent in harvesting Korean. The usual practice with Kobe and Korean is to cut and rake the crop while the dew is on and allow it to dry in the windrow and then run it through an ordinary grain thresher. Since the Kobe shatters more readily than the Korean the former variety must be harvested rather promptly after the seed has matured. The combine-harvester has been used by a few growers for harvesting lespedeza seed. Some growers prefer to cut the lespedeza with a mower and rake in the windrows, and after it is sufficiently dry, they use the combine with a pick-up attachment for threshing out the seed. In a few instances the combine has been used to harvest lespedeza seed in much the same way as in harvesting grain.

WEEDS

Weeds are usually more troublesome in thin stands of lespedeza than they are where the ground is well covered, and for that reason many growers prefer a heavy seeding—35 to 40 pounds of seed per acre. Even in thick stands there may be considerable weed growth when lespedeza is sown alone. There is less trouble from early season weeds when lespedeza is sown on small grain. Later in the summer, however, other weeds may come up through it. There is no very satisfactory way to control weed growth when lespedeza is sown on weedy land. The usual practice is to clip the weeds once or twice a year with a mower. The first clipping is made while the lespedeza is small. It usually retards the weed growth sufficiently to permit the crop to outgrow the weeds. Early clipping is seldom necessary when lespedeza follows small grain. Later in the season ragweed and other summer-growing weeds may make a second clipping desirable. This clipping is made with the cutter bar of the mower set high and if there is much weed growth the weeds are raked up and hauled off the field.

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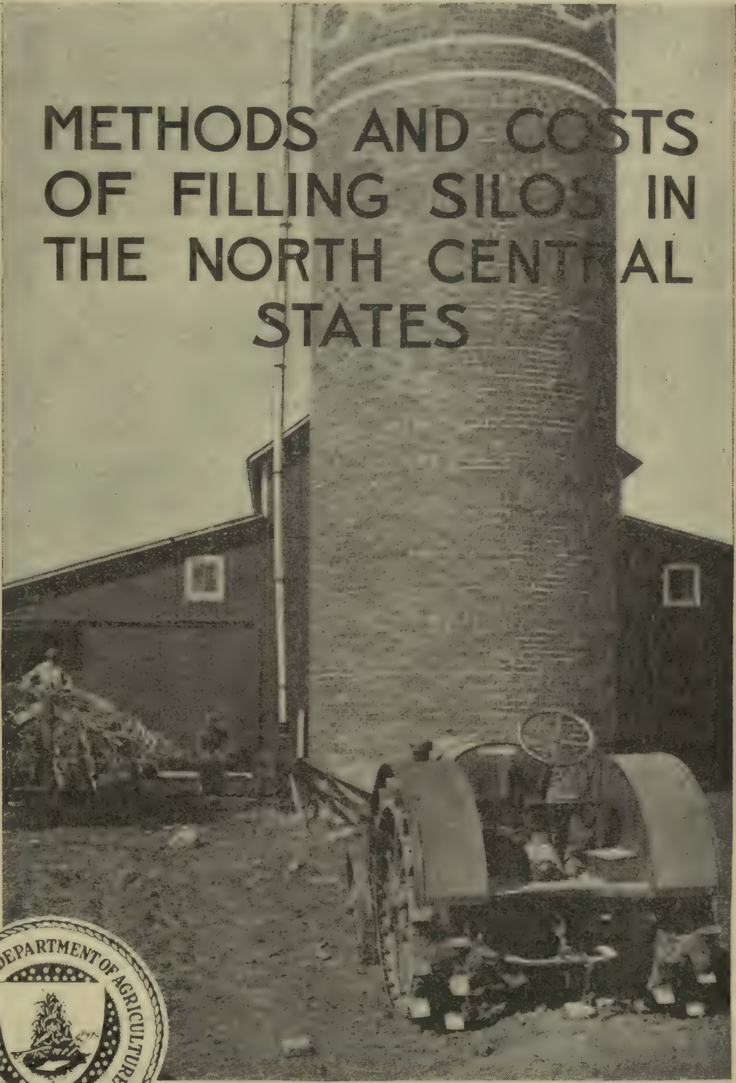
FARMERS' BULLETIN No. 1725

METHODS AND COSTS OF FILLING SILOS IN THE NORTH CENTRAL STATES



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SILO FILLING is an important task on many farms. Silage would be a more common feed were it not for the expense and labor required in filling the silo. Improvements in methods and equipment which decrease the expense and lessen the labor are important in determining the cost of farm operation.

Two types of equipment are used in filling silos—the stationary cutter, which cuts the corn into small pieces and elevates it into the silo, and the field silage harvester which cuts the standing corn and cuts it into small pieces in one field operation. With the latter equipment a blower elevates the finely cut corn into the silo. When stationary cutters are used the corn may be cut in the field by hand or by binders. If binders are used the bundles of corn may be dropped on the ground or loaded directly on the wagon by means of an elevator attachment.

The cost of filling a silo varies with the type of equipment. The average cost in Illinois, according to the study on which this bulletin is based, was $1.49 per ton on farms where stationary cutters were hired, $1.41 on farms where stationary cutters were owned, and $1.31 per ton on farms where field harvesters were used.

Using a field harvester involves substituting power and equipment for part of the man labor used in filling the silo with the stationary cutter. On an average, the investment in equipment was more than twice as high, and twice as much tractor power was used when the filling was done with field harvesters, but 21 percent less man labor and 27 percent less horse work were used. Cash costs made one half the total when stationary cutters were hired, one third when they were owned, and one forth when field harvesters were used. One of the chief advantages of the field harvester is the possibility of using family labor or labor that could not be used so well around a stationary cutter, thus reducing the total cost and the cash cost of filling.

Washington, D.C. Issued May 1934

METHODS AND COSTS OF FILLING SILOS IN THE NORTH CENTRAL STATES

By Kenneth H. Myers, *associate agricultural economist, Division of Farm Management and Costs, Bureau of Agricultural Economics*[1]

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INTRODUCTION

The corn crop from approximately 4,000,000 acres is converted into silage in the United States each year. This method of harvesting and storing the corn crop is used in all parts of the country but is most common in the dairy regions, and, to a lesser extent, in beef-cattle-feeding areas. Corn is cut for silage on approximately 375,000 farms or on an average of about 1 farm in 17. Wisconsin leads in total number of farms on which silage is fed—more than 90,000, or about one third the total number of farms. Twenty-five percent of the farms in New York and 20 percent of those in Minnesota reported this method of harvesting corn in 1929. Corn is cut for silage on more than one half the farms in the dairy area in northern Illinois.

The presence of the European corn borer in the United States has caused more attention to center on equipment and methods for harvesting corn. The continued spread and increased numbers of borers will necessitate the adoption of farm practices by which the entire corn plant is fed to livestock or otherwise disposed of. Cutting for silage or fodder is an effective method of controlling the borer if the corn is cut at the ground surface, and may be the most economical method of control where the silage or fodder can be fed to dairy or beef cattle.

Improvements in silo-filling machinery and the development of new methods have eliminated much of the drudgery of silo filling and, with the increased use of farm tractors, have been important factors in promoting individual farm ownership of such machinery. These developments have made the choice of equipment and methods more difficult for the individual farmer, however, since much labor is replaced by power and equipment. The farmer must consider, with respect to conditions on his farm, the ownership of silo-filling machinery, the type and size of equipment, and the size and organization of the crew. On farms on which the necessary equipment is already owned there is little alternative so far as machine ownership or type

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[1] Acknowledgment is due M. A. Crosby, Division of Farm Management and Costs, for assistance in preparing the manuscript.

of equipment is concerned since the cost of making a change would more than offset any advantage gained. On farms on which no equipment for filling is owned, or on which the old equipment is so depreciated that it cannot be used further, a choice must be made between buying new equipment or hiring a machine, and if the operator decides to purchase new equipment the choice of type and size is important. The most economical size and organization of the crew may vary from farm to farm, and from year to year on the same farm, with changes in the supply of labor, relative prices of labor and power, and other factors.

SCOPE AND PURPOSE OF STUDY

This study is based on data collected in 1928 and 1929 by the Department of Farm Organization and Management, University of Illinois, in cooperation with the Bureau of Agricultural Economics, United States Department of Agriculture. Records of the cost of filling upright silos were obtained on 87 farms in Illinois on which stationary cutters were used and on 118 farms on which field harvesters were used. Practices and equipment in silo filling have not changed appreciably since the data were gathered. It is believed the conclusions are approximately applicable to most parts of the country where upright silos are used. They are particularly applicable to conditions in the North Central States.

Since then the wages of farm labor have fallen to about 48 percent, the cost of horsepower to about 50 percent, and the cost of tractor power to 85 percent of the rates obtaining during the years of the study. These changes and changes in the future should be taken into account by farmers in using the figures given in this bulletin.

The purpose of this bulletin is (1) to show the elements of cost involved in filling upright silos by different methods and practices, (2) to show the relative importance of these elements of cost and the factors affecting them, and (3) to present a basis for selecting and combining them in such manner as best to fit conditions on the individual farm. As it is assumed that the farmer is committed to the practice of making and feeding silage, no attempt is made to show its advantages or disadvantages. Nor is the cost of producing the corn crop considered since in most areas the methods used in producing silage corn are similar to those used in producing corn for grain.

TYPES OF EQUIPMENT AND INITIAL COST

Two methods in which the equipment is entirely different are used for filling silos in the United States. The most common method is that in which corn is cut in the field, hauled to the silo, and cut up for silage with a stationary cutter. The field silage harvester was first put on the market in 1918 and is not widely used. It cuts the standing corn and chops it into silage lengths in one operation, after which the material is elevated into the silo by means of a blower (figs. 1 and 2).

The stationary cutters are all of the same general type, varying only in mechanical construction, and, more important, in size. There are wide variations, however, in the equipment and methods used in cutting the corn in the field and hauling it to the silo. The maximum cutting capacity of stationary cutters varies largely with the size, but on most farms the rate of filling depends on the number of men hauling the corn to the silos. The field harvester is made in only one size, and the only equipment used with it are box wagons for hauling the cut corn to the silo and a blower to elevate it. The small amount of strenuous labor required in filling with this machine makes it possible to utilize a class of labor that cannot be used around a stationary cutter.

The newer field harvesters are drawn and operated by a tractor equipped with a power-take-off device. They have proved more efficient and satisfactory than the earlier machines, which were drawn by horses, the cutting mechanism being operated by a gasoline motor mounted on the frame of the machine. The older type of cutter was used on nearly two thirds of the farms studied, and there seemed little difference in the cost of filling.

The amount of capital required to buy silo-filling equipment is relatively large in relation to the amount of use that can be made of such equipment on many individual farms. Insufficient capital, or alternative uses for that which is available, lead many farmers to hire custom outfits to fill their silos, or leave little choice as to type of equipment to be purchased. This is particularly true in the case of tenant operators, whose capital is closely limited or whose terms of occupancy may be uncertain.

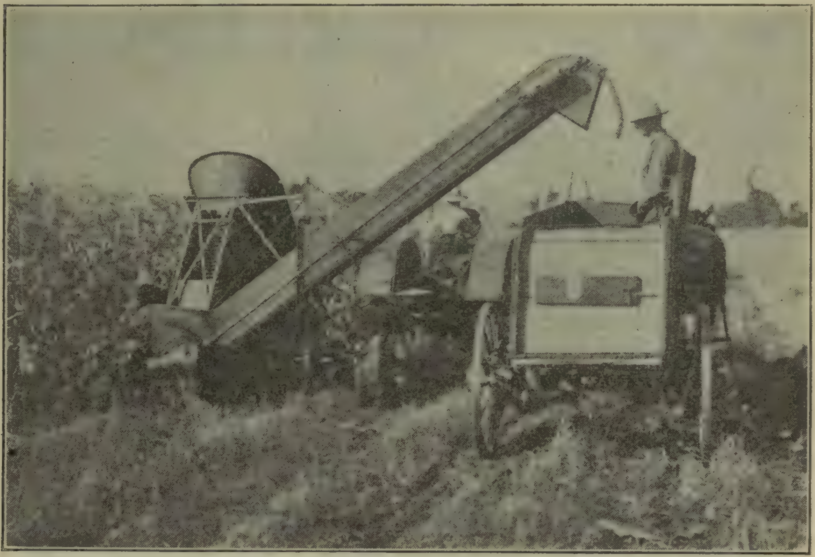

FIGURE 1.—Cutting corn with a field silage harvester.

The amount of capital required depends on the methods and equipment used in cutting the standing corn, and on the type of equipment used in cutting the corn into silage length. The average initial cost of the silo-filling equipment used on the farms studied was as follows: Stationary cutter, $375; corn binder without elevator, $175, and with an elevator, $225; field harvester, $625; blower, $225. Most of the equipment used on these farms was bought during the 8 to 10 years previous to the time the study was made. Small stationary cutters may be bought for less, however, and if the corn is cut by hand the necessary investment per farm may be kept at a much lower figure than is indicated by these prices.

EQUIPMENT OWNERSHIP

Private ownership of silo-filling equipment has become common, and the relatively high investment has been justified by a saving in labor costs and amount of time used in filling. In many instances the necessary capital is supplied by two or more farm operators, and the equipment is owned and operated cooperatively. In localities in which silos are common the necessary equipment may be hired, frequently at less cost than if a machine were owned. In addition to regular custom outfits operated entirely for profit, many farmer-owned machines are used on neighboring farms in exchange for power or labor, and some custom work often is done to provide profitable work for the regular labor and at the same time reduce the overhead cost of filling the home silo.

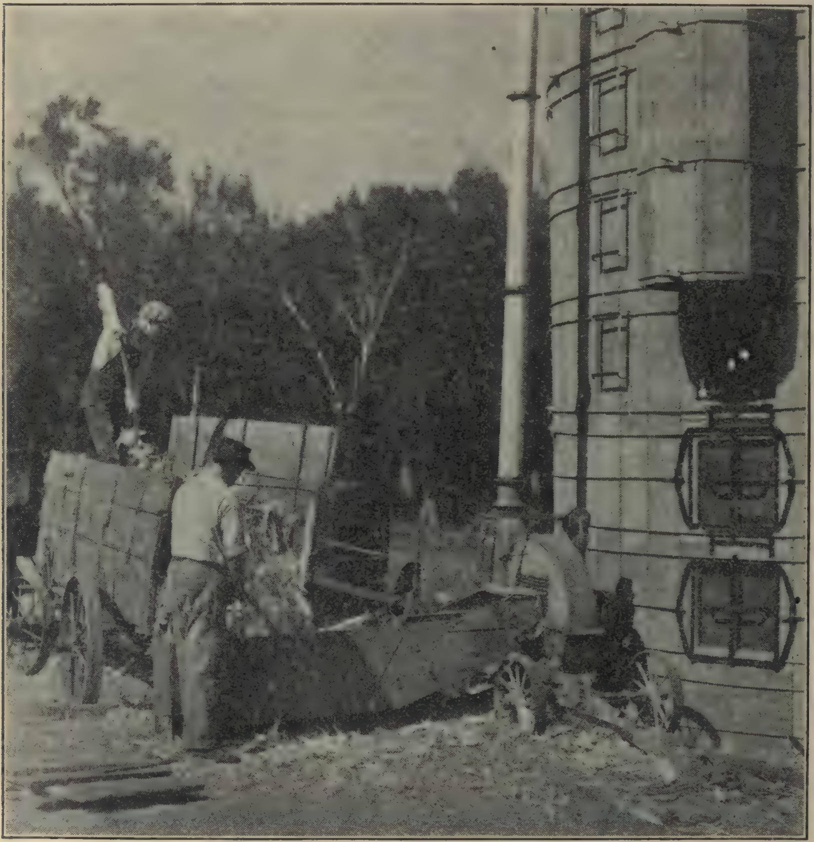

FIGURE 2.—Elevating silage material cut by a field silage harvester. On many farms a wagon hoist is used to lift the front end of the wagon, allowing the material to slide into the blower hopper.

The farm tractor has been an important element in promoting farm ownership of belt-operated equipment. Many tractors are bought with a view to reducing the cost of hiring power and equipment for belt work and with the knowledge that they would otherwise not be used enough to justify the investment. If power for filling silos has to be hired its cost may more than offset any advantage of owning silo-filling equipment.

Cooperative ownership of equipment often solves the problem of securing the initial capital and of providing labor and power for silo filling. Overhead costs decrease as the amount of corn cut by each machine increases, and the investment per farm is lower when the machine is owned cooperatively. The number of farms included in such an agreement, however, should be no more than are needed to provide the necessary capital, labor, and power.

Stationary cutters were hired on nearly half of the farms in this study on which this type of machine was used, and most of those hired were regular custom outfits. They are more generally used in custom filling than field harvesters because of greater flexibility in the possible rate of filling and because of the smaller investment. Field harvesters were hired on several of the farms, but none could be classed as regular custom machines.

The cost of hiring a custom machine represents a definite cost of operating the farm and takes the place of depreciation, interest, repairs, and shelter costs on the same equipment if owned on the farm. Owners of custom outfits charge more for the use of their machines than barely enough to cover these costs, but because of the large quantity of silage cut by many custom machines during the season, the cost per ton of silage to the silo owner often is less than with a machine that is used only on 1 or 2 farms even though it is efficiently operated.

Custom machines often are difficult to get at the time when the corn should be cut for silage, and, since they usually are large, much hired labor must be used in order to keep the custom charge as low as possible.

The amount of time required to fill the silo is a common basis for determining the custom filling charge. The rate varies, but the most usual charge in 1928 and 1929 was $4 per hour, plus the cost of fuel, for the cutter and tractor and the wages of two men. Only the time that the machine is in position and ready to fill is counted; the time required to set the machine and that lost through breakdowns is not included in the filling time. This basis for payment is probably the most equitable to both parties. The silo owner usually provides a large crew in order to complete the filling in as short a time as possible, and this in turn enables the machine owner to fill a larger number of silos during the season.

On some farms the custom charges are based on the estimated capacity of the silo, or a flat charge is made for the entire job. These bases for payment often lead to disagreement since the capacity of the silo varies with the amount of tramping, the condition of the corn, and other factors, and the time required to fill the silo depends on the size of the crew provided by the silo owner.

CAPACITY OF EQUIPMENT AND POWER REQUIREMENTS

The quantity of silage material cut during the season, the number of men, and amount of time available for filling silos, are important considerations when selecting equipment. If the equipment is to be used on several farms and a relatively large amount of labor is readily available, a machine with a high cutting capacity should be used in order to complete the job before the corn is too dry to make good silage, and to use the available labor efficiently. If only a small acreage is to be cut on 1 or 2 farms, the rate of filling is less important than is the efficient use of a small crew of men. In that case a small machine should be selected.

The maximum capacity of stationary cutters depends on the size of the cutter, length of cut, number of knives, and the speed at which the cutter is driven. Tests have shown, however, that most medium-sized cutters are operated at not more than 40 to 60 percent of their full capacity. The maximum rate of cutting, even with a 14-inch machine, is limited by the rate at which the corn can be fed into the machine and not by the ability of the machine to cut and elevate the corn. With a small machine, or with large machines poorly adjusted, the cutting capacity of the machine may be the limiting factor in determining the rate of filling.

On the farms studied, there appeared little relationship between the size of machine and rate of filling, chiefly because the size of the crew was not determined by the size of the machine. There was a distinct relationship, however, between the size of crew and rate of filling. On farms where crews of less than 10 men were used, an average of 5.4 tons was cut per hour; where 10 to 14 men were on the crew, an average of 8.2 tons was cut per hour, and where 15 to 19 men were used, the average rate of cutting was 10 tons per hour.

The rate of cutting with the field harvester depends on the yield of silage material per acre and on the ability of the operator to keep the machine running steadily. An average of about 5.5 tons of corn was cut per hour on the farms studied, and although the amount varied from 2.5 to over 15 tons, from 5 to 7 tons was cut per hour on over one half of the farms. As the yield of silage material increases, the machines are forced to travel at a lower speed to enable the cutting mechanism to handle the crop, but the quantity of corn cut per hour increases. The mechanical ability of the operator is more important with this type of filler than with the stationary cutter if maximum speed is to be attained. The field harvester blower easily handles the chopped corn at the silo as rapidly as it can be cut in the field.

Steam engines, tractors, stationary gas engines, and electric motors are used to furnish power for filling silos. The common farm tractor usually furnishes sufficient power except on farms where large stationary cutters and large crews are used. The amount of power necessary to cut at maximum speed with a stationary cutter depends on the size of the cutter, the speed at which it is driven, the height of the silo, and the rate of feeding the cutter. In earlier years steam engines were often used for filling with stationary cutters, but they were used on only 8 percent of the farms studied in 1929. Three-plow, or larger, tractors were used on nearly two thirds of the farms on which the filling was done with a stationary cutter.

Two power units are required in filling with the field harvester—one to pull the cutter in the field and one to operate the blower at the silo. Condition of the ground, size and condition of the corn, and the rate of travel are important factors in determining the amount of power necessary to pull the field cutter. The power requirements of the blower used with the field harvester are similar to, but less than, that of stationary cutters since no cutting is done with the blower. Nearly two thirds of the power-take-off field harvesters were pulled by 3-plow tractors, while 2-plow tractors were used on about the same proportion of the blowers at the silos. Less power is required to operate the blower than to pull the field harvester, and where both a 2- and a 3-plow tractor were available the larger machine usually was used in the field. Three horses were used to pull most of the motor-mounted field harvesters, but on 10 farms tractors were used. The rate of cutting was about the same on the farms studied where either 2- or 3-plow tractors were used to pull the cutter except where the corn was unusually heavy or dry, or when the ground was soft and wet. Under these conditions the larger tractor was more effective.

The slight differences in the rates of cutting on farms where different sized cutters and tractors were used indicate that neither the full capacity of the cutter nor all the available power is used on many farms. Most efficient operation is obtained only when available power, labor, and equipment are used at near full capacity. This is not always possible, but it should be kept in mind when selecting the equipment and when organizing the crew for filling the silo.

AMOUNTS OF LABOR, POWER, AND MATERIALS USED IN FILLING SILOS

The amounts of labor, power, and materials used in filling silos vary with the equipment used and the method of performing certain parts of the filling process. The average amounts of labor and power used in filling with stationary cutters and with field harvesters on the farms from which data were collected are given in table 1. In many localities, particularly in the eastern dairy region, smaller crews are used and the silo-filling job is spread over a longer period by permitting the cutting and filling equipment to be idle a part of the time.

TABLE 1.—*Average amounts of labor and power used in filling upright silos in Illinois with stationary cutters and with field harvesters, 1928 and 1929*

Item	Farms on which stationary cutters were used			Farms on which field harvesters were used
	Farms where corn was cut in the field by hand	Farms where corn was cut in the field with a binder	All farms	
Farms .... number	26	47	[1] 87	118
Corn cut per farm .... acres	11.7	18.8	16.1	15.7
Silage made per farm .... tons	99	139	121	130
Yield of silage corn per acre .... do	8.4	7.4	7.5	8.3
Average size of crew .... men	16.6	10.3	12.0	6.8
Amount cut per hour of man labor .... tons	.67	.42	.57	.80
Labor and power used per acre:				
Man labor .... hours	20.1	11.0	13.2	10.4
Horse work .... do	14.5	16.6	16.0	11.7
Tractor use .... do	1.21	1.07	1.11	2.3
Labor and power used per ton:				
Man labor .... do	2.38	1.49	1.76	1.25
Horse work .... do	1.72	2.24	2.14	1.40
Tractor use .... do	.14	.15	.15	.28

[1] On 14 farms part of the corn was cut by hand and part with a binder.

Less man labor and less horse work are involved in filling with the field harvester than with stationary cutters, but more tractor power is necessary. Likewise, less man labor is necessary when a binder is used to cut the corn for filling with stationary cutters, but more horse work is used than when the corn is cut by hand. The investment in equipment is also increased, and more materials, such as fuel, oil, and twine, are used when this labor-saving equipment is used.

The process of filling the silo may be divided into four operations for the purpose of studying the costs involved. These divisions are (1) cutting the corn in the field, (2) loading and hauling the corn to the silo and unloading it on the cutter table, (3) operating the cutter or blower and power unit, and (4) tramping the silage in the silo. A fifth, which includes labor in setting up the machine, putting in doors, and general supervision, is often necessary. Each of these operations represents a separate problem in determining the equipment and the number of men used, but each must be considered in its relation to the others in making the final choice of equipment and size of crew.

MAN LABOR

CUTTING CORN IN FIELD

Corn usually is cut with a binder in localities in which relatively large acreages are cut for silage or fodder. Binders eliminate the hard work of cutting corn by hand and have the added advantage in some localities of making it possible to secure hired or exchange labor more easily and at lower rates. Bundle elevators, which convey the bundles directly from the binder to the wagon as the corn is cut, are used on many farms (fig. 3). This attachment, primarily, is a further step toward making silo filling easier and less disagreeable, since more man labor and horse work often are used and the investment in equipment is increased. The use of the elevators, however, increases the quantity of corn hauled by each man.

An average of 5.10 hours of man labor was used per acre in cutting corn by hand on the farms studied; 1.55 hours per acre where the corn was cut with binders and the bundles dropped on the ground; and 1.85 hours where binders were equipped with bundle elevators. Operating at these rates in average corn, one man cuts about 1.6 tons per hour by hand, about 5.4 tons with a binder if the bundles are dropped on the ground, and 4.4 tons if the bundles are elevated directly to wagons. The rate of cutting with binders equipped with bundle elevators is lower than when the bundles are dropped on the ground since the binder must stop while an empty wagon is brought into position to receive the bundles, and often must stop to allow the hauler to arrange the bundles on the wagon, unless an additional man drives the team. Two or three binders often are necessary when elevator attachments are used since then no corn can be cut before filling is started. When corn is cut by hand or a binder without the elevator, it is a common practice to start cutting a day in advance of the filling, so the silage cutter is kept busy without using two binders or an unusually large crew of hand cutters.

Cutting in the field is the most important operation when field harvesters are used since the corn is also cut into silage lengths at the same time and the speed of this operation determines the rate of filling. All the power-take-off field harvesters and all the horse-drawn motor-mounted machines were operated by one man. An average of 1.43 hours was used in cutting an acre with power-take-off machines, and an average of 1.57 hours was used with the motor-mounted horse-drawn machines. Motor-mounted machines were pulled by tractors instead of horses on 10 farms, but two men were necessary, and the rate of cutting was not increased. It was, therefore, not an economical practice.

HAULING CORN TO THE SILO

Nearly 50 percent of all labor used in filling silos with stationary cutters is employed in the operation of loading the corn on the wagon, hauling to the silo, and unloading at the cutter table. Many operators are willing to add some to the cost of filling if this operation can be made easier, but little change can be made except through the use of labor-saving equipment. Low-wheeled wagons or special wagons with low-slung racks make the loading somewhat easier but make unloading more difficult since the corn must then be lifted to the cutter table.

FIGURE 3.—Cutting corn with a binder equipped with a bundle elevator.

The method of cutting in the field has a direct bearing on the ease of handling the corn and on the number of men required in hauling. Bundle corn can be handled more rapidly and with more ease than the loose corn, particularly if the bundles are made small enough to be handled easily. An average of 1.14 hours of labor was used per ton in loading and hauling corn which had been cut by hand as compared with 0.93 hour where the corn was cut with a binder and the bundles dropped on the ground.

Extra pitchers are often used to help load the wagons in the field, especially when custom machines are hired and the aim is to fill as rapidly as possible without adding more teams and wagons. This makes the work easier on the haulers but increases the size of the crew and the total amount of man labor used. On farms on which each hauler loaded his own wagon an average of 0.91 hour of labor per ton was used in hauling, while an average of 1.21 hours was used where extra pitchers were employed. But an average of 1.28 tons of silage was hauled per hour on each wagon when extra pitchers were used, as compared with 1.10 tons when each man loaded his own wagon.

Bundle elevators eliminate entirely the work of lifting the corn to the wagons. Two or more binders are often necessary, however, and extra men to drive the wagon teams enable the haulers to load the bundles properly without stopping the binder. This increases the total amount of man labor used but also increases slightly the rate of filling with the same number of wagons and teams. An average of 0.72 hour of man labor per ton was used in hauling when each hauler drove his own team, and an average of 0.83 hour was used when extra drivers were employed; but the quantity of silage material hauled per hour on each wagon was increased from 1.38 to 1.66 tons.

The field harvester eliminates all the heavy work of loading and unloading the whole corn since the cut corn is elevated into box wagons drawn alongside the machine, and is pushed or shoveled out of the back of the wagon into the blower hopper at the silo. If a wagon hoist is available it is used to lift the front end of the wagon, thus letting the corn slide into the hopper. If the distance to the field is not great, 3 or 4 men can haul the chopped corn as fast as it can be cut. An average of 0.58 hour of man labor was used per ton in hauling from the field to the silo. One great advantage of the field harvester is that a less able class of labor can be utilized. On many farms the older men and younger boys who could not be efficiently used around a stationary cutter make full hands here, and usually their wage rates are lower.

OPERATING THE TRACTOR AND CUTTER OR BLOWER

The rate of filling with stationary cutters is determined on most farms by the number of men hauling corn and the rate at which they feed the cutter. The number of men at the machine usually varies with the kind of power unit, the type of cutter, and the number of men hauling. Only in cases where large cutters and large crews are used is the number of men operating the machine a factor limiting the rate of filling.

The wages of 2 men, who operate the tractor and cutter, are usually included in the amount charged for custom machines, but 1 man usually tends both if the equipment is owned on the farm. One man can operate the tractor and blower, elevating the silage material as fast as the corn can be cut with a field cutter, but in some cases each hauler unloads his own load, and no one stays at the silo. Less labor is used by this method, but it is not a good practice unless someone definitely is responsible for the care of the tractor and blower.

The total amount of labor used in operating the tractor and stationary cutter, or blower when a field harvester is used, depends on the number of men and the rate of filling. An average of 0.23 hour per ton was used in operating the tractor and stationary cutters and the tractor and blower on farms where field harvesters were used. The amount used on individual farms varied a great deal, but on an average the difference in number of men operating the tractor and cutter or blower was balanced by differences in the rate of filling.

TRAMPING SILAGE AND MISCELLANEOUS WORK

Tests have shown that tramping is not necessary for making good silage. But the silage must be tramped if as much corn as possible is to be put into the silo without refilling, especially when the filling is done rapidly. A silo with a capacity of 120 tons on one farm was filled in 1 day with no tramping, and after the material had settled for a few days was not over three fourths full. When 2 or more days are used in filling, the silage settles from its own weight, and tramping becomes less important. On the farms studied the number of men used in tramping ranged from none to 5, 1 man being most commonly used where stationary cutters were owned, and 2 men where custom machines were hired. On 44 percent of the farms on which field harvesters were used the silage was not tramped, and 1 man was used for this work on about the same number of farms.

Setting up the machine, chore work, and making repairs made up less than 5 percent of the total labor used in filling with stationary cutters, and about 9 percent of that used in filling with field harvesters. Much of the chore work can be done when the entire crew is not on the job, but repairs that hold up the entire crew increase the amount of man labor used and likewise the cost of filling.

FUEL AND OIL

The cost of fuel and oil used in silo filling varies with the method of filling, the kind and size of the power unit, the rate of filling, the general running condition of the equipment, and other factors. The average quantities used with different equipment on the farms are shown in table 2. More fuel is required in filling with field harvesters than with stationary cutters since two power units are necessary and the amount of time is not reduced. From 25 to 30 percent more fuel was used in three-plow tractors than in two-plow tractors, and nearly two and a half times as much fuel was used when motor-mounted field harvesters were pulled by tractors. Less fuel is used in filling with stationary cutters when the rate of filling is relatively high, but the yield of silage material per acre is a more important factor when field harvesters are used.

Table 2.—*Quantities of fuel and oil used in filling upright silos with stationary cutters and field harvesters, 1928 and 1929*

Equipment used	Farms	Yield per acre	Silage cut per hour	Quantities used per 100 tons of silage	
				Fuel	Oil
Stationary cutters:	*Number*	*Tons*	*Tons*	*Gallons*	*Gallons*
2-plow tractors [1]	24	7.6	6.6	30.0	1.63
3-plow tractors [1]	48	7.6	7.7	37.6	1.53
Field harvesters:					
Power-take-off cutters:					
2-plow tractors	13	7.8	5.6	30.4	1.41
3-plow tractors	24	8.3	5.7	36.6	1.39
Motor-mounted cutters:					
Horse-drawn [2]	49	8.2	5.2	22.7	2.26
Tractor-drawn	10	9.4	5.2	56.0	4.14
Blowers:					
2-plow tractors	58	8.4	5.5	26.9	1.31
3-plow tractors	38	8.0	5.3	35.8	1.71

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[1] For the purpose of this study, tractors with ratings of 12–27 horsepower or larger were considered as 3-plow tractors, while those with lower ratings were considered as 2-plow tractors.

[2] Includes that used in the tractor and in the motor on the cutter.

Usually there is no alternative in the kind of fuel except as gasoline and kerosene are interchangeable, since the available power unit must be used. The use of tractors in pulling motor-mounted field harvesters and binders is not common and is not an economical method under usual conditions. The amount of fuel used and filling costs are reduced by having the power unit and cutter in proper adjustment and in condition to operate efficiently, and by cutting at a speed that makes the maximum use of the available power.

TWINE

Twine is an element of cost in filling silos when the corn is cut with a binder and handled in bundles. The amount used per acre varies with the weight of the crop, the range being from 2.75 pounds per acre for yields between 4 and 6 tons, to about 4.5 pounds per acre where the yield is from 12 to 14 tons per acre. On the farms on which the corn was cut with a binder and bound, the average yield of silage material was 7.5 tons per acre and the average amount of twine used was 3.3 pounds per acre, or approximately 0.44 pound per ton.

COST OF FILLING SILOS

The selection of a method of filling silos is a practical problem with which each silo owner is concerned. If no equipment is owned he must give consideration to such problems as the ownership of the equipment with which he fills his silo, the type of equipment, the method of cutting corn in the field if a stationary cutter is used, and the size and organization of the crew. On some farms no alternative may be open to the operator; then such factors as available capital, power available on the farm, and the capacity of the equipment determine the kind and ownership of the equipment. On most farms, however, the choice is determined largely by relative costs.

The average costs of filling on the farms studied are shown in table 3. Average costs on farms where stationary cutters were owned and where they were hired are shown, as well as costs for two classes of field harvesters, the power-take-off machine and the motor-mounted type. The costs are first itemized in detail and are then combined in four divisions according to their nature and significance in determining the cost of operating the farm. Before the costs in table 3 are discussed this classification may be examined.

CLASSIFICATION OF COSTS

"Direct cash costs" include hired labor, fuel and oil, twine, repairs on equipment, and custom charges paid for the use of hired equipment. Under all circumstances such costs have a direct influence on the decision of the farmer since they add to the immediate cost of operating the farm.

"Unpaid costs", as here used, include the assigned value of those elements contributed by the farmer himself and his family, and the permanent elements in the organization of his farm. Proprietor and family labor, the use of work stock regularly kept on the farm, and the use of farm buildings for housing equipment, are included in this group. It is true that these costs eventually must be met in full if farming is to be profitable, but the cost of operating the farm is not necessarily increased by making maximum use of these permanent elements in the farm organization. Alternative opportunities for using these elements may make their cost of greater importance.

TABLE 3.—*Cost of filling upright silos with stationary cutters and field harvesters, based on average amounts of labor, power, and materials used in Illinois, 1928 and 1929*

Item	Farms on which stationary cutters were used		Farms on which field harvesters were used [1]	
	Owned machines	Hired machines	Power take-off machines	Motor-mounted horse-drawn machines
Farms.................number..	47	40	39	49
Area cut per farm.................acres..	17.5	14.5	21.5	14.4
Yield per acre.................tons..	7.6	7.3	8.2	8.2
Itemized average costs per 100 tons of silage: [2]				
Hired labor.................dollars..	35.15	32.02	19.47	19.57
Unpaid labor.................do....	35.15	32.02	29.21	29.35
Horse work.................do....	29.33	30.57	15.24	24.55
Tractor:				
Depreciation and repair.................do....	9.22	2.17	16.71	9.14
Interest.................do....	4.97	1.17	9.00	4.92
Stationary cutter:				
Depreciation.................do....	5.00	----------	----------	----------
Interest.................do....	2.40	----------	----------	----------
Repairs.................do....	1.95	----------	----------	----------
Binder:				
Depreciation.................do....	3.66	4.23	----------	----------
Interest.................	1.46	1.45	----------	----------
Repairs.................do....	.62	.59	----------	----------
Field harvester:				
Depreciation.................do....	----------	----------	15.24	15.18
Interest.................do....	----------	----------	5.94	5.92
Repairs.................do....	----------	----------	1.91	2.21
Field harvester blower:				
Depreciation.................do....	----------	----------	3.03	3.00
Interest.................do....	----------	----------	2.26	2.25
Repairs.................do....	----------	----------	.22	.68
Fuel and oil.................do....	6.35	5.56	10.81	11.80
Twine.................do....	3.50	4.43	----------	----------
Wagon use.................do....	1.67	1.62	1.23	1.23
Building charge.................do....	.68	.44	.88	.88
Custom charge.................do....	----------	32.40	----------	----------
Total cost.................do....	141.11	148.67	131.15	130.68
Classified and combined cost per 100 tons of silage: [3]				
Direct cash costs.................dollars..	47.57	75.00	32.41	34.26
Unpaid costs.................do....	65.16	63.03	45.33	54.78
Depreciation.................do....	19.55	8.02	36.21	28.55
Interest.................do....	8.83	2.62	17.20	13.09
Total cost.................do....	141.11	148.67	131.15	130.68

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[1] Data from 20 farms where machines were hired and from 10 farms where motor-mounted machines were pulled by tractors were not used in estimating these costs.

[2] The following rates for labor, power, and materials were used to determine the cost of filling silos in 1928 and 1929: Man labor, 40 cents per hour; horse work, 14 cents per hour; tractor use, 90 cents per hour for 3-plow size and 40 cents for 2-plow size, 65 percent of which was depreciation and repairs and 35 percent of which was interest; fuel, 13.4 cents per gallon for kerosene, 16.4 cents for gasoline, and oil at actual cost; twine at actual cost; and wagon use at 2 cents per hour. An average life of 15 years was estimated for the stationary cutters, during which time an average of 500 tons is cut each year. With an average initial cost of $375, a charge of 5 cents a ton was made for depreciation and 2.4 cents for interest. Binders were estimated to have a life of 12.5 years, cutting 40 acres each year and having an average intiial cost of $175, or $225 when bundle elevators were used; a charge of 35 cents was made per acre when no elevator was used and one of 45 cents when the elevator was used. On the basis of estimates made by the operators, field harvesters were estimated to have an average life of 12 years, cutting a total of 500 acres during that time. The average price paid for the machines was about $625. Depreciation was charged at $1.25 per acre and interest at 48.75 cents an acre. By the same method the average life of the blower was estimated as 24 years, during which time it would put up 7,500 tons of silage. The initial cost was $225; depreciation was charged at 3 cents per ton and interest at 2.25 cents per ton. The allocated cost of housing the field harvester and blower was estimated at $3 per year.

[3] Direct cash costs include hired labor, repairs, fuel, and oil, twine, and custom charges. Unpaid costs include operators' and other family labor, horse work, and building charges. Depreciation includes depreciation and repairs on the tractor, depreciation on the stationary cutters, field harvester and blower, and binder, and wagon costs. Interest includes interest on the tractor, stationary cutter, field harvester, blower, and binder.

On many farms depreciation is very similar to the unpaid costs. Depreciation represents a cash outlay at some previous time, but once the equipment is bought its use does not represent a cash expense exclusively for the operation concerned—filling silos in this case. Depreciation, as a replacement cost, usually is distributed over the life of the equipment, but, in an emergency, its consideration often may be deferred. Furthermore, a certain amount of depreciation takes place through weathering and obsolescence, even though the equipment is not used. Depreciation on such equipment as tractors, binders, and silo-filling equipment, which have many wearing parts and on which repairs are costly, are more important than on many simpler machines. Although it may be disregarded during a single year on farms where such equipment is already owned, it should be considered carefully by the operator who is considering the purchase of new equipment.

Finally, there is interest, which might also be considered as unpaid costs, but which is put in a separate classification in order to make the picture a little clearer. The purchase of new equipment increases the amount of capital invested in the farm business on which interest must be paid or from which some return may be expected. Additional use of equipment already on the farm, however. does not increase the total annual interest charge to the farm.

USE OF COST DATA IN SELECTING A METHOD OF FILLING SILOS

The average cost of filling silos with stationary cutters on the farms studied was $1.41 per ton when the equipment was owned by the farm operator and $1.49 per ton when a custom machine was hired. It cost $1.31 per ton to fill with a field harvester, either a power-take-off or motor-mounted type. These average costs include all of the items that have been discussed—direct cash costs, allowance for depreciation and interest on equipment, the assigned value of the operator's labor and that of his family, cost of housing the equipment, and the cost of horse work.

Do these average costs give conclusive answer to each individual farmer's question of how he shall fill his silo? If he has in the past hired a custom machine to fill his silo, can he conclude that he can save 18 cents a ton by buying a field harvester, or that he can fill with a field harvester for 10 cents a ton less than if he owned a stationary cutter? Not at all. The cost data presented in table 3 represent the average on many farms on which conditions varied greatly. They cannot represent accurately the costs on a specific farm.

In the first place the relative prices paid for labor and materials vary from farm to farm and from year to year. In determining the feasibility of buying equipment, relative costs must be calculated on the basis of prices existing on each farm. In the second place both the total costs and the relative importance of the different classes of costs vary with conditions on each farm. In addition to conditions which affect the money cost of filling, such factors as the operator's personal preference as to exchanging labor with neighbors, the customs in the community, and alternative uses for capital, labor, and power often must be considered.

The use of field harvesters involves the substitution of power and equipment for a large part of the man labor used in filling with stationary cutters. Man labor (table 3) makes up nearly 50 percent of the total cost of filling with the owned stationary cutter, 43 percent when one is hired, and 37 percent when the field harvesters are used, while depreciation and interest on equipment equaled 20 percent, 7 percent, and 30 to 40 percent, respectively. A reduction of one half in the cost of man labor, with other costs remaining the same, would make filling with stationary cutters cheaper than filling with field harvesters. On an average, the use of custom machines increases the cost of filling and particularly the direct cash cost, but in many cases a machine may be obtained in exchange for labor or power, which at that time has little alternative use, and at a lower cost than if a cutter were owned.

The importance of some costs, as shown in table 3, may be discounted on some farms and under certain economic conditions. Under conditions existing in recent years, it is particularly important that cash costs be kept at a minimum. The average cash cost of filling with field harvesters in 1928 and 1929 was about 33 cents a ton as compared with 48 cents on farms where stationary cutters were owned and 75 cents when custom machines were hired. Depreciation, which represents replacement costs, may be disregarded for a year or so, but should be considered in determining the costs of filling over a period of years. Direct cash costs and depreciation amounted to more than 68 cents a ton when the modern power-take-off field harvester was used in 1929 as compared with 67 cents where a stationary cutter was owned.

Unpaid costs and interest may enter into the consideration in an entirely different way from cash costs or depreciation. These costs should be considered, but in the immediate situation the individual farmer may be willing to use his own and other family labor, and his capital, without the hope of getting the desired return for its use. He may decide to do this merely because if he does not he will get nothing for it and he feels that a small return is better than nothing. Alternative uses for this labor and capital, therefore, are an important consideration in determining the value the farmer places on their use.

FACTORS AFFECTING THE COST OF FILLING SILOS

Average costs, such as are shown in table 3, represent the combined effect of a great number and variety of conditions, and cannot be expected to indicate relative costs on an individual farm under certain conditions. Some of the factors affecting the costs and the relative importance of the different classes of costs are (1) quantity of corn cut, (2) yield per acre, (3) amount of regular labor available on the farm, (4) cost of hired labor, and (5) alternative uses for labor, power, and capital.

The amount of use made of silo-filling equipment affects the different classes of costs in different ways. The costs of hired labor, fuel, twine, and custom charges increase directly with the quantity of silage material cut. Depreciation costs increase with the amount of use made of the equipment but at a lower rate, since weathering and obsolescence become relatively less important as the equipment is used more. The amount of capital invested depends on the kind of equipment. Only a small amount is required if a custom machine is hired, while a field harvester costs considerably more than a stationary cutter. Interest charges, therefore, do not increase with the amount of time which the equipment is used. "Unpaid costs" increase with the quantity of silage material cut, but little importance should be attached to them if there is no other productive work on which family labor and the available horsepower could be used at the time when the silo is being filled. Thus, on a farm on which a small quantity of silage material is cut, cash costs would be doubled if twice as much silage material were cut, but depreciation charges would not be increased proportionately, interest charges would show no increase, and the additional unpaid costs might be considered of little importance under the conditions. On some farms on which only a small quantity of silage material is cut, these overhead costs are reduced by doing custom work, by filling in exchange for labor, or through cooperative ownership of equipment.

The yield of corn per acre is a factor in determining not only the cost of filling from farm to farm with the same type of equipment but also the relative cost by different methods. As the yield per acre decreases, the necessary number of men cutting corn, either by hand or by machine, and the number hauling the corn to the silo, must be increased if the same rate of filling is maintained. This additional help usually must be hired; so low yields affect particularly the cash costs. Yield is more important when the filling is done with a field harvester than when a stationary cutter is used, since the rate of filling is determined by the quantity of corn cut per hour by the field cutter. Less time is required to cut an acre in low-yielding corn, but the quantity of corn cut per hour is reduced. More fuel and oil are used and depreciation on the field cutter increases with the acreage cut regardless of the yield, resulting in higher costs per ton of silage.

One of the greatest advantages of the field harvester is the small crew necessary to operate the machine at full capacity, making it possible to use regular farm labor to a greater extent. Family and regular hired labor made up 52 percent of the total labor used on farms where field harvesters were owned as compared with 28 percent where stationary cutters were owned and 14 percent were stationary cutters were hired. More time is required to fill, but the cash cost is materially reduced unless extra labor must be hired to return the exchange labor. A further advantage is the possibility of using labor that could not be used in filling with a stationary cutter. For example, one field harvester on which information was obtained was owned by two brothers living on adjoining farms. One year these 2 men, their father, 2 boys, and 1 hired man filled their 2 silos with a combined capacity of 231 tons in 32.5 hours. Neither the father nor the boys could have helped much in filling with a stationary cutter, but made full hands in driving the wagons since no heavy work was involved. On another large dairy and beef cattle feeding farm, on which 8 to 10 men were regularly employed, and on which several large silos had to be filled a field harvester had been discarded. It was found that the available labor was more efficiently utilized and the filling was accomplished in less time with a medium-sized stationary cutter.

The relation of the cost of hired labor to the total cost varies with the method of filling. Hired labor, as shown in table 3, makes up about 21 percent of the total cost of filling with a custom outfit, 25 percent where a stationary cutter is owned, and less than 15 percent where a field harvester is used. The relative advantage of the field harvester is greatest, therefore, when the price of hired labor is high and the possibility of using less able and less expensive labor increases this advantage.

The choice of equipment may be influenced and the relative costs of filling determined by the amount available or by alternative uses for the available capital, labor, and power. No capital is invested if a custom machine is hired, but the cash costs are higher. The effect on the farm income, if these elements of production are used in other phases of the farm business, may determine their value in filling silos. Capital invested in other equipment or improvements may return a greater income than if used to purchase a silo filler. Family labor and horse work are important items of cost only if they may be used in other work, at that time, which would increase the farm income or decrease the operating expenses of the farm.

The ease of filling or amount of leisure time may be considered on farms where costs by different methods appear similar. The usual custom in the community or consideration for neighbors may also be important in some instances. On 1 farm 2 silos, each with a capacity of 256 tons, were filled. The large quantity of silage made it almost impossible for this man to exchange labor with his neighbors. A new field harvester would have necessitated hiring another tractor and would not have reduced the time used very much. The operator, 2 regularly hired men, and 2 extra hired men filled these silos in 125 hours with a 16-inch stationary cutter, cutting the corn in the field with a binder equipped with an elevator.

The effect of these factors on the total cost of filling by different methods and on the distribution of costs may be seen more easily by making some estimates on a single farm. On one of the farms studied a custom machine was hired to fill a silo holding 175 tons. A custom charge of $4 per hour, plus the cost of fuel, was paid for the tractor and cutter, and the labor of two men. Labor was exchanged with four other farmers in the community and, in order to fill as rapidly as possible, a crew of 15 men was used in addition to the machine men. A total of 67.5 hours was required to fill the 5 silos, and since only the operator was on the farm at this season of the year it was necessary to hire 2 men for the entire period. The costs of filling with the custom machine and the estimated costs if a stationary cutter or a field harvester had been owned are shown in table 4. It is estimated that with his own stationary cutter this farmer can cooperate with only 3 other men and fill the 4 silos in 72 hours with a crew of 10 men. In case the field harvester was owned, the cooperation of only 1 other is desirable, and with 6 men the 2 silos will be filled in 48 hours. One difficulty with individual ownership of the field harvester is the necessity for two tractors. In this case it may be agreed that each farmer will furnish a tractor and that the farmer cooperated with will pay the estimated depreciation costs on the field cutter and blower in filling his silo. As these costs will about equal the cost of hiring a tractor, neither is included in the costs shown.

The estimated costs, based on prices prevailing in 1929, were $1.17 per ton when a custom machine was hired and would have been $1.08 if a stationary cutter had been owned and $1.05 if a field cutter had been purchased. Cash costs were even more in favor of the field harvester, being 77 cents per ton when a custom machine was used, 45 cents with an owned stationary cutter, and 36 cents with a field harvester. Depreciation and interest, however, are greatest when the field harvester is used and amount to only a small part of the total cost when a machine is hired. Under these conditions costs are in favor of the field harvester. What will be the effect on these costs and their distribution (1) if only half as much silage is cut; (2) if the yield of corn per acre is materially different; (3) if more unpaid labor is available, and (4) if labor and material costs are changed?

TABLE 4.—*Cost of filling a 175-ton silo with a custom machine on one farm in 1929, and estimated costs if a stationary cutter and field harvester had been owned*

Item	When hired stationary cutter was used	If owned stationary cutter had been used	If owned field harvester had been used
	Dollars	*Dollars*	*Dollars*
Cash costs	135.28	78.21	63.02
Unpaid costs	53.85	57.20	36.60
Depreciation	10.21	29.49	49.96
Interest	5.67	23.34	34.89
Total	205.01	188.24	184.47

If only 87.5 tons of corn were cut, all costs, with the exception of interest, presumably would be reduced accordingly. But interest makes up only 2.8 percent of the total when a machine is hired, 12.4 percent when a stationary cutter is owned, and 18.9 percent when a field harvester is owned. So far as total costs are concerned, therefore, the custom machine would be the most economical method, while the field harvester is the most expensive. Cash costs, likewise, are reduced by half when a field harvester is owned unless the smaller quantity of corn enabled the operator to return a greater part of the exchange labor with unpaid labor, in which case the costs would be reduced more than half.

A lower yield of corn per acre would increase the acreage of corn required. More labor and power would be used in cutting the corn and depreciation on the binder would be increased accordingly when stationary cutters are used. The rate of filling would also be reduced unless additional labor is hired for cutting and hauling corn. If the yield is reduced one third, the cost of filling with the custom machine is increased about 12.4 percent and with an owned cutter about 14.1 percent. In the case of the field harvester, however, depreciation on the tractor and field cutter would be increased 50 percent, and nearly 50 percent more fuel would be used. Not more than five men would be needed, since the rate of cutting would be lower, but the total labor bill would be increased nearly 10 percent, while slightly less horse work would be used. The total cost, however, is increased about 22.5 percent and is more than if a stationary cutter is owned and nearly as much as if one is hired. Yield is important, therefore, in determining the relative economy of the field harvester.

The amount of family labor available does not affect the total cost but does affect the amount of hired labor and thus the cash cost of filling. If there were two unpaid members of the family, the cash cost of filling with the custom machine would be reduced $27, with the owned stationary $28.80, and $19.20 if a field cutter is used. Not only family labor but regular hired labor, which would be paid even if the silo were not filled, should be considered in this way.

The cost of hired labor affects both total costs and their distribution. Labor costs make up a larger proportion of the total when stationary cutters are used; so low-cost labor reduces the advantage of the field harvester. If labor can be obtained at 25 cents an hour instead of 40 cents, the cost of filling with the stationary cutters on this farm is reduced nearly 15 percent but less than 12 percent in the case of the field harvester. The possibility of using less-able labor, boys, or elderly men, with the field harvester, however, always offers a chance of further reducing the cost of filling with the field harvester.

ORGANIZATION OF CREW FOR FILLING SILOS

The size and organization of the crew used in filling silos should be determined by the type of equipment used, the amount of unpaid labor and exchange labor available, the cost of hired labor, and the amount of time available for filling.

The rate of filling with the field harvester is determined by the capacity of the field cutter, and three or four men with teams can almost always haul the chopped corn from the field to the silo as fast as it is cut. One man usually is kept at the silo to tend the tractor and blower, help unload, and put doors in the silo. Tramping is considered unnecessary in filling with the field harvester since the lower rate of filling usually gives sufficient time for the material to settle from its own weight. The most efficient number of men is not so difficult to determine when this type of equipment is used.

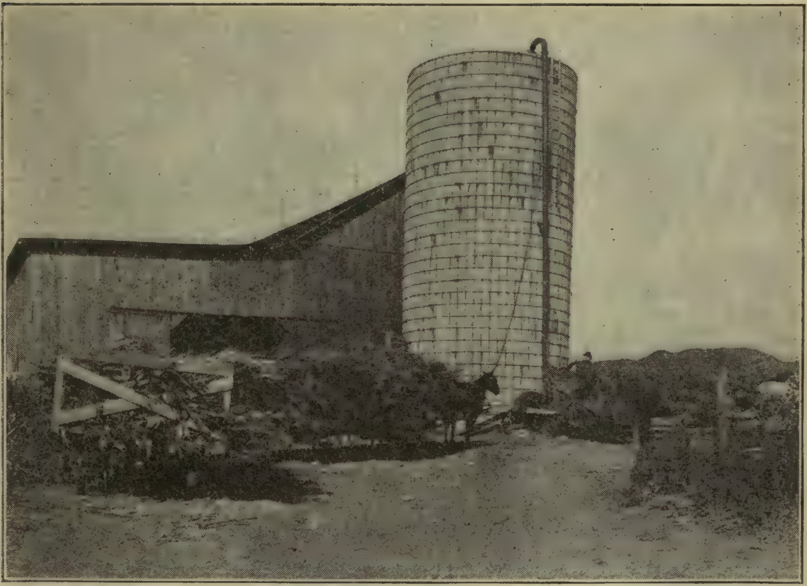

FIGURE 4.—Inefficient crew organization. The number of men and their distribution should depend on the capacity of the cutter so that there will be a minimum amount of waiting.

The organization of the crew used in filling with the stationary cutter is not so simple. Except in cases where very small cutters are used or where sufficient power is not available, the number of men hauling corn from the field is the limiting factor in determining the rate of filling. The necessity or desire of the silo owner to fill slowly or rapidly should determine the size of the crew in most cases (fig. 4). Where a custom machine is hired and the cost determined by the amount of time used, a large crew is economical in most cases.

If a machine is owned, however, and no other work at which the regular labor can be more effectively used is available, the cash cost usually is reduced by filling more slowly with a small crew in order to use unpaid or exchange labor as much as possible.

The approximate quantity of corn that one man with the usual power unit may be expected to handle per hour is shown in table 5. The rate of cutting corn in the field is especially affected by the yield per acre, but the quantity of corn hauled per man is also affected, so the data in table 5 are adjusted for corn yielding about 8 tons of silage per acre. As the rate of performance is also affected by other factors such as the distance the corn is hauled, the type of corn, and size of crew in relation to size of cutter, the expected range, due to these factors, is also shown.

TABLE 5.—*Approximate quantities of corn handled per unit of man labor and power in corn yielding 8 tons of silage material per acre* [1]

Operation and method	Quantity per unit	Expected range in quantity	Operation and method	Quantity per unit	Expected range in quantity
	Tons	*Tons*		*Tons*	*Tons*
Cutting corn in field by hand	1.6	1.0–2.2	Hauling corn cut with binder with elevator:		
Cutting corn in field with binder:					
Without elevator	5.4	4.4–6.4	Without extra drivers	1.5	1.2–1.8
With elevator	4.4	3.4–5.4	With extra drivers	1.6	1.4–1.8
Hauling corn cut by hand:			Cutting corn with power-take-off field harvester	5.8	4.0–7.6
Without extra pitchers	1.0	.7–1.3			
With extra pitchers	1.2	.9–1.5	Cutting corn with motor-mounted field harvester	5.2	4.2–6.2
Hauling corn cut with binder without elevator:					
Without extra pitchers	1.3	1.0–1.6			
With extra pitchers	1.4	1.1–1.7			

[1] One unit of man labor, and power consists of 1 man plus 2 horses in hauling corn, 3 horses in cutting with a binder or motor-mounted field harvester, or 1 tractor in the case of the power-take-off field harvester, the combination working 1 hour.

Given a farm on which a medium-sized stationary cutter is owned with sufficient power and labor available to fill a 180-ton silo in 2 days or about 18 hours; how many men will be needed, and how must they be distributed if the corn is cut with a binder and the bundles dropped on the ground?

A study of the figures in table 5, indicates that 2 binders are necessary to complete the job in the time specified, or 1, if it cuts 1 entire day before filling is started. Since 1 man can haul about 1 ton per hour, 10 men with teams and wagons are necessary, or if 2 or 3 extra pitchers are provided to help load the wagons in the field, 8 men may be sufficient. Two men should be kept at the silo when cutting at this rate, 1 to feed the cutter and 1 to tend the tractor and cutter. In order to fill the silo fairly full at least 2 men should tramp; and there probably should be 1 man to put in doors, tend the water, and do other miscellaneous tasks.

This arrangement makes a crew of at least 17 men. More will be needed if the distance from the field to the silo is unusually great or if the yield of corn per acre is lower. If the corn is cut by hand, 6 men are necessary in cutting unless some corn is cut the day before. If binders with the elevator attachments are used, three binders probably will be necessary, but not more than 7 men will be needed for hauling.

The size of crew probably is more often determined by the number of men available than by the speed at which it is desired to fill. Suppose 10 men are available on this farm; what should be their distribution? One man must tend the cutter and tractor, 2 men should tramp, put in doors, etc., while 1 man with a binder can cut the corn. This would leave 6 men to haul corn, and the silo would be filled at the rate of about 6.5 to 7.5 tons an hour. Since one binder can cut only about 5.5 tons an hour some cutting must be done the day before. If elevator attachments are used on the binders, two binders would be necessary, and 5 men would be left to haul corn to the silo. The 5 men could not keep both binders cutting steadily, but this would be preferable to using one binder and delaying the haulers.

The organization of the crew is an important factor in obtaining economic and efficient operation. The choice of equipment is made only once in several years, but the most efficient crew must be determined each year, on the basis of local conditions.

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This bulletin is a contribution from

Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Division of Farm Management and Costs	C. L. HOLMES, *Principal Agricultural Economist, in Charge.*

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